LANGLEY RESEARCH CENTER

IMPLEMENTATION PLAN

1999

The illustration on the cover is symbolic of the work and commitment of the employees of Langley Research Center. Two-thirds of the illustration represents aeronautical research with the silhouette of an aircraft. One-third of the illustration depicts a night sky that represents space research. Approximately two-thirds of Langley's work is aeronautical research and one-third is space research. The large circle is symbolic of the earth and indicates our involvement with earth science. The seven stars are in memory of the seven astronauts lost during the Challenger accident.

NASA LANGLEY RESEARCH CENTER

IMPLEMENTATION PLAN

1999

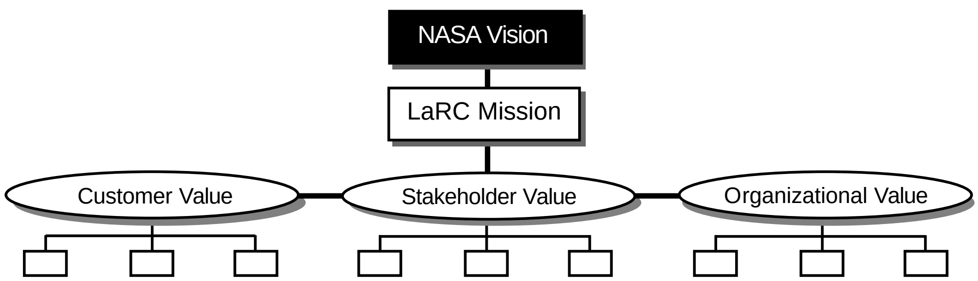
http://larcip.larc.nasa.gov/

Strategic and Quality Framework and Implementation Plan of Langley Research Center

The Langley Strategic and Quality Framework (SQF) is designed to be an enduring, overarching guide for the overall management of the Center. It identifies three factors which are critical to Langley's success: providing value to our customers, informing our stakeholders of our value to the Nation, and increasing our productivity by striving to be a high performance organization.

The SQF reflects how the Center will operate more effectively and aligns with the NASA Strategic Plan, the National Performance Review, and the Government Performance and Results Act. The Implementation Plan describes what Langley is doing to support the goals and objectives described in the NASA Strategic Plan and the NASA Performance Plan.

To focus the efforts of both managers and employees on the three critical success factors, nine strategic goals have been identified which encompass all types of work performed at the Center. Performance measures accompany the critical success factors and strategic goals as indicators of the success of our contribution to achieving the NASA vision.



Customer Value

Customers value our partnership, use our products, and understand our role.

- Programs constitute a strategically balanced portfolio developed in partnership with customers.
- Investments and productivity are enhanced by partnerships with customers, educational institutions, and other government agencies.
- Technical programs are effectively accomplished to meet customer commitments.

Stakeholder Value

Stakeholders' decisions reflect that LaRC returns good value on their investments.

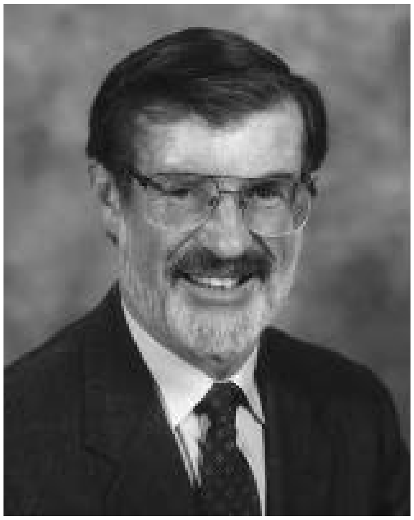
- Mission and programs are known to the public.
- Strategic partners support mission and programs.
- National decision makers support mission and programs.

Organizational Value

Langley is an organization that learns, adapts, and improves to benefit employees, customers, and stakeholders.

- Increased value to customers and stakeholders is the key criterion for development, deployment, and recognition of employees.
- Labor/management partnership benefits LaRC.
- All processes efficiently deliver quality products and services.

Director's Message



Langley Research Center celebrated its 80th Anniversary in 1997. Langley employees, past and present, are extremely proud of the contributions Langley has made to the Nation in the fields of both Aeronautics and Space over the last eight decades.

As we move toward the 21st Century, we are excited about the new opportunities and challenges set forth by the NASA Strategic Plan and the more specific goals of the four NASA Enterprise Plans.

Langley has developed a Strategic and Quality Framework (SQF) which explains **how** Langley will accomplish its mission in support of the NASA Strategic Plan and the Enterprises. The SQF booklet, distributed to all Langley employees, describes our focus on the three critical success factors noted on the opposite page. This Implementation Plan summarizes **what** commitments we have made in support of the NASA Programs.

The Implementation Plan defines the relationship of strategies from Enterprise Plans to the roles, missions, Center of Excellence, program-specific assignments, Lead Center responsibilities, and the Agency support activities of the Center. This document is the communications tool used to enable the Center's customers to see that their requirements are being addressed and to ensure that Center employees understand their contributions to the highest level strategies and objectives of NASA.

The work we do aligns with the NASA Strategic Plan and sustains our core competencies. We are contributing to all four Enterprises and hold Agency leadership in several critical areas.

As we accomplish our goals, Center employees are urged to devote energies to the important things, to work safely and efficiently, to do what we do with excellence, to finish what we start, and to have and project a positive attitude. With everyone at the Center focusing on his or her contribution to our critical success factors, we enhance our value to the Nation by carrying out our mission with the same standard of technical excellence that has traditionally characterized Langley.

Jeremiah F. Creedon
Director, Langley Research Center

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Vision, Mission, and Values

The Langley Mission Statement is consistent with the Agency Mission Statement but delineates our unique role. It recognizes our focus on customers and our use of strategic alliances to enable us to do more and obtain more use of results. The Langley contribution to the NASA Vision is to be the world leader in pioneering science and innovative technology to enable U.S. aeronautical and space preeminence.

The NASA Vision

NASA is an investment in America's future. As explorers, pioneers, and innovators, we boldly expand frontiers in air and space to inspire and serve America and to benefit the quality of life on Earth.

The Langley Mission

In alliance with industry, other agencies, and academia, we develop airframe and synergistic spaceframe systems technologies to enable preeminence of the U.S. civil and military aeronautics and space industries; in alliance with the global research community, we pioneer the scientific understanding of the Earth's atmosphere to preserve the environment.

The Langley Values

Integrity*—We are committed to maintaining the highest level of ethical conduct in fulfilling responsibilities to our customers, suppliers, and coworkers.*

Technical Excellence—*Our products and services are recognized by customers, stakeholders, or peers to be of exceptional significance.*

People—*A highly skilled diverse workforce is our most important resource. Every individual is valuable and deserves respect. We create an environment that fosters*

- Commitment
- Innovation
- Trust
- Teamwork
- Continuous Improvement

Flexibility—*We adapt and thrive in an environment of continual change, both as an organization and as individuals.*

Missions and Roles of Langley Research Center

Primary Mission Assignments

Airframe Systems

Atmospheric Sciences

Center of Excellence Assignment

Structures and Materials

Lead Program Assignments

Advanced Subsonic Technology

High Speed Research

Airframe Systems Research and Technology

Aviation Safety

Agency Functional Assignments

Independent Program Assessment

Reusable Launch Vehicle System Analysis Support

Space Science Enterprise Implementation Support

Wind Tunnel Facility Group

Agency Support Activities

Program Manager for Non-Destructive Evaluation

Lead for Scientific and Technical Information

Lead for Program/Project Management Initiative Training

Introduction

Purpose

The purpose of the Langley Research Center (LaRC) Implementation Plan is to translate the NASA Strategic Plan, NASA Performance Plan, and the Enterprise Strategic Plans into actions by summarizing the commitments of LaRC to Agency performance targets, the Enterprise Strategic Plans, Functional/Staff Office Plans, and other government agencies. The Implementation Plan presents Langley's approach to implementation, as reflected in approved run-out budgets. Every Langley employee will see the relationship of his or her work to the NASA mission through the Implementation Plan. Langley customers will see that their requirements are addressed. The Implementation Plan will be updated annually as part of the strategic management process to reflect changes in the NASA Strategic Plan, the Enterprise Strategic Plans, the NASA Performance Plan, and the Program Plans.

Relationship to Strategic and Quality Framework

The intent of the Implementation Plan is to bridge the gap between the Enterprise Strategic Plans and the detailed Program Plans for specific areas within each Enterprise or Office. The Implementation Plan indicates what Langley is specifically committed to accomplish. The companion document, *LaRC 1996-97 Strategic and Quality Framework*, explains how the Center has focused the attention of all Langley employees on performing our work more effectively and how we use our core competencies to fulfill our commitments and to provide value to both our customers and stakeholders. The combined documents accurately depict the **what** and **how** of the Langley approach to implementing its assigned goals and objectives.

Missions and Roles

The major missions and roles assigned to the Langley Research Center are listed on page VII. Our primary mission assignments are Airframe Systems and Atmospheric Sciences. Langley is also designated the Agency Center of Excellence (COE) for Structures and Materials. A brief description of these and our other assignments follows.

Primary Mission Assignments

Airframe Systems

The primary mission assignment for LaRC in support of the Aeronautics and Space Transportation Technology (ASTT) Enterprise is for Airframe Systems research. The Airframe Systems mission area is comprised of specific competency areas that, taken as a whole with those areas assigned to the other Code R centers, specify the primary dimensions of the Code R programs. These competency areas are used by Code R in selecting lead Centers for both Research and Technology Base activities and Systems Technology programs. LaRC core competency areas supporting the Airframe Systems mission are mission and systems analysis; aerodynamics, aerothermodynamics, and hypersonic airbreathing propulsion; structures and materials; airborne system and crew station design and integration; and systems engineering. The Center has a number of research facilities which support this mission area and has been given the additional Agency responsibility (described later) for facility management oversight for wind tunnel, aerothermodynamic, and aero-propulsion facilities. In carrying out the Airframe Systems mission, LaRC interacts with external customers, other government organizations, universities, and other NASA Centers to ensure that planning, development, coordination, and program implementation result in successful accomplishment of the ASTT Enterprise goals and objectives.

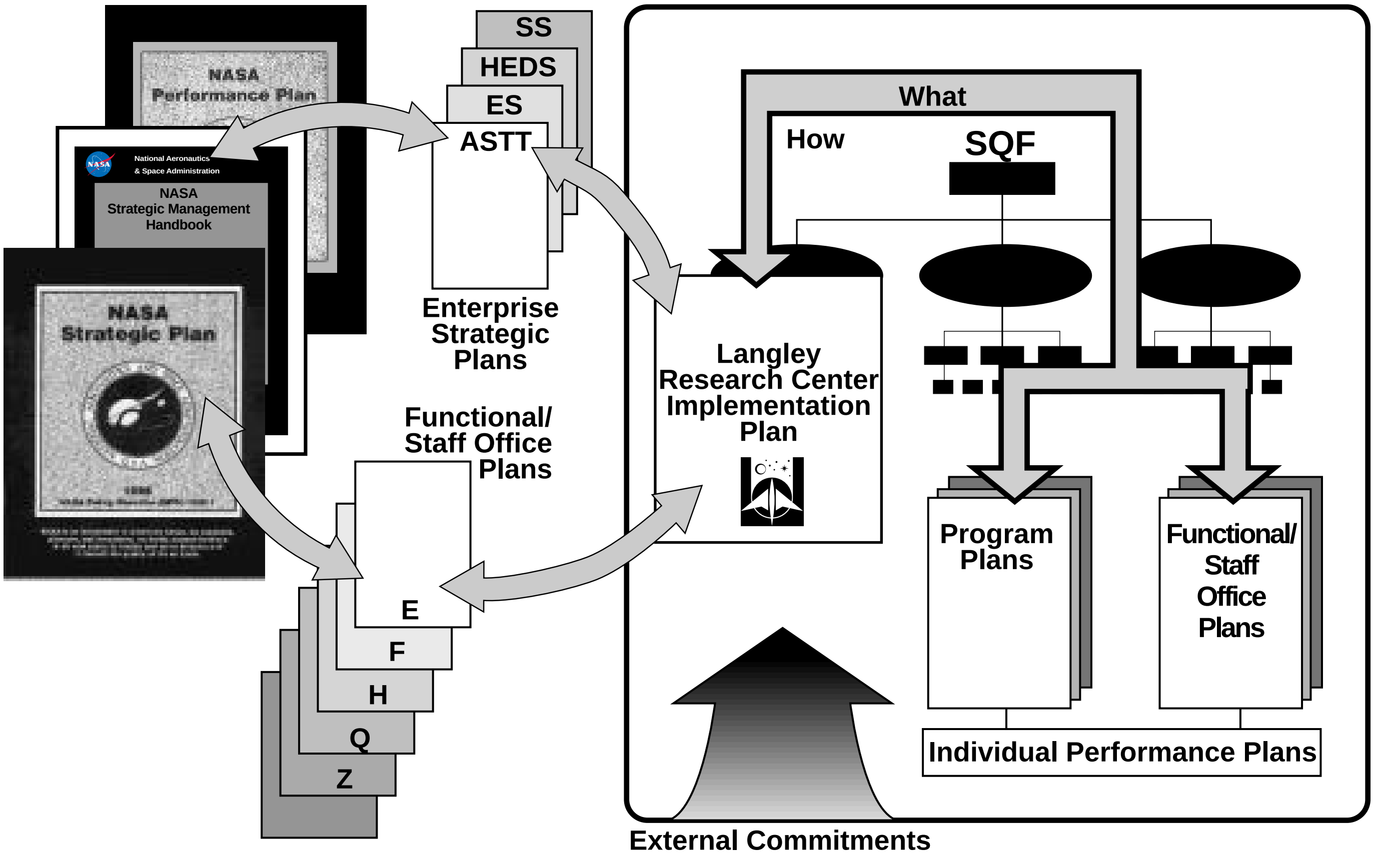

Figure 1. Relationship of Langley SQF and Implementation Plan to Agency management system.

Atmospheric Sciences

Langley has been given the mission responsibility for Atmospheric Sciences. The goal of the program is to meet the challenge of understanding the ever changing atmosphere of the Earth by collecting data and conducting research, which will help improve the knowledge of the current state of the atmosphere, as well as our understanding of human-induced and naturally occurring changes to the atmosphere. Langley will be working with other NASA Centers, other government agencies, industry, and the academic community to better understand the processes that affect the structure and the make-up of the atmosphere. Some of these processes are radiation balance, chemical interactions, and dynamics (physical motions of the atmosphere). Current research is directed toward better measurements of some of these parameters from ground-based instruments and instruments on satellites, aircraft, and balloons and in the laboratory. These measurements are complemented by theoretical investigations that analyze atmospheric measurements with techniques such as statistics or computer modeling simulations. In addition, advanced technology development at Langley is directed toward reducing cost of future generations of atmospheric science instruments and enabling new measurement capabilities.

Center Of Excellence Assignment

Structures and Materials

Langley has been designated the NASA COE for Structures and Materials. Langley will provide the leadership for coordination, planning, advocacy, and assessment of the structures and materials research and technology development activities throughout the Agency. Langley will promote the development of new material systems and processes, innovative structural mechanics and dynamics design and analysis methods, experimental techniques, and advanced structural concepts through technology validation for aircraft, space transportation vehicles, science instruments, and spacecraft. Langley will address technology challenges to enable more affordable, lighter weight, higher strength and stiffness, safer, and more durable vehicles for subsonic, supersonic, and sustained hypersonic flight; Earth and other planetary atmospheric entry; and spacecraft flight throughout the solar system.

The COE will be led by the COE Office at Langley with strategic partnerships established among the NASA Field Centers, forming the COE community. The COE Office will provide the strategic leadership required to implement the functional responsibilities of the COE. The COE community will be responsible for maintaining and enhancing the preeminent technical and programmatic expertise and ground test facilities and laboratories distributed throughout the Agency. The COE Community will develop and maintain partnerships with industry, academia, and other government agencies to leverage external programs and resources to achieve NASA strategic objectives. The COE Office will coordinate with the other COE’s and key NASA Headquarters Offices, as appropriate, to effectively and efficiently meet the research and technology needs of all the NASA Strategic Enterprises.

Lead Program Assignments

Advanced Subsonic Technology

Langley has been designated as the lead Center for the management and implementation of the Agency's Advanced Subsonic Technology (AST) Program. The goal of NASA’s Advanced Subsonic Technology Program is to develop high risk, high payoff technologies to enable safe travel in the global air transportation system with environmentally compatible aircraft at reduced seat cost. The Program is conducted in cooperation with the Federal Aviation Administration (FAA), the U.S. aeronautics industry, and universities and is aimed at benefiting the flying public. Critical roles in the program are played by Ames Research Center (ARC), Lewis Research Center (LeRC), Goddard Space Flight Center (GSFC), and Langley Research Center (LaRC).

High Speed Research

Langley has been designated as the lead Center for the management and implementation of the Agency's High Speed Research (HSR) Program. Langley coordinates development of critical technologies in aero-dynamic performance, airframe materials and structures, flight deck technology, propulsion technologies (implementation at LeRC), and system integration elements. These elements include Technology Integration, Environmental Impact, TU-144 Experiments, and Atmospheric Effects of Stratospheric Aircraft (implementation at GSFC) that will enhance the economic viability and environmental compatibility of the High Speed Civil Transport (HSCT). Langley maintains an ongoing relationship with airframe and propulsion industry partners, including Boeing, Pratt & Whitney, General Electric, and Honeywell, to ensure timely delivery of HSR technology, to ensure protection of the technology for our nation's civil aerospace industry and to respond to changes in industry time lines and requirements.

Airframe Systems Research and Technology

Langley has been designated as the lead Center for management and implementation of the Airframe Systems Research and Technology Base Program. The objective of the Airframe Systems Program is to pioneer the development of advanced technology concepts and methodologies, provide advanced tools and techniques, respond quickly to critical national issues, and provide the basis on which future focused programs are built. The Airframe Systems Program will pioneer the identification, development, verification, transfer, and application of high payoff technologies. These technologies are aimed at providing benefits in one of six critical elements: advanced vehicle concepts, tools and test techniques, high-performance aircraft, aviation safety, breakthrough technologies, and systems analysis. The program is conducted in cooperation with the U.S. industry, the Federal Aviation Administration, the Department of Defense, and the academic community.

Aviation Safety

Langley has been assigned lead Center responsibility for NASA's role in a national aviation safety initiative. The initiative is intended to develop the technology applications to enable an 80 percent reduction in the fatal accident rate by 2009 and a 90 percent reduction by 2019. The Langley office is developing the program plan for the new Aviation Safety Program. Some of the ongoing aviation-safety work at Langley will continue within the R&T Base, including Airframe Systems R&T. NASA is developing new partnerships with the FAA to promote timely technology application within the aviation system. NASA is also coordinating with the Department of Defense (DoD) and other government agencies. The program approach attacks several classes of challenges: preventing accidents, making accidents more survivable, and obtaining/analyzing in-depth safety data from the national aviation system. Focused, high payoff research will address all vehicles classes--commercial, rotorcraft, and general aviation--and also build strong partnering relationships with industry. Ames Research Center, Lewis Research Center, and Dryden Flight Research Center play important roles in this work.

Agency Functional Assignments

Independent Program Assessment

Langley has been assigned the Agency lead role for conducting independent assessments of advanced concepts under consideration for advanced development and for the administration of reviews conducted in support of the Office of the Administrator and the Program Management Council (PMC). Responsibilities include supporting the Administrator regarding the approval of program development activities; conducting independent, multidisciplinary analyses and assessments of evolving aerospace systems designs moving from an advanced concept stage to that warranting consideration as a fully approved program; improving the quality of our program planning and verifying the feasibility of systems development and operational success; and scheduling, organizing, and conducting the PMC's Nonadvocate Reviews (NAR's), and Independent Annual Reviews (IAR's).

Reusable Launch Vehicle System Analysis Support

Langley provides program systems analyses, conceptual designs, and technology systems benefits for space access and hypersonic vehicles to NASA, DoD, and industry. For the reusable launch vehicle technology investment decision process. Langley provides the ASTT (Aeronautics and Space Transportation Technology) Enterprise with vehicle concept definition and analyses. Trade studies and performance analyses provide results that are used for selection of vehicle options and identification of design risk for vehicle development.

Space Science Enterprise Implementation Support

Langley provides expertise and support in science mission acquisition to the Office of Space Science (OSS), ensuring that the criteria for high quality science return within cost and schedule are met. The primary responsibilities of Langley are in acquisition for Discovery and Explorer science missions. Langley develops initial Announcements of Opportunity and NASA Research Announcements for assigned programs; supports the overall evaluation and selection process; manages and conducts the technical, management, cost and other factors (TMCO) evaluations of proposals; and provides constructive feedback to the scientific community and their partners to enhance the quality of future proposals. Langley works with the OSS and its customers, which include academia, industry, NASA Centers, and other government agencies to develop the most efficient and innovative methodologies that minimize proposal preparation and evaluation impacts.

Wind Tunnel Facility Group

Langley has been assigned the lead role for wind tunnel aerothermodynamic and aeropropulsion facility strategic management and will facilitate national alliances between NASA, DoD, U.S. industry, and possible foreign interests. The strategic management oversight includes creating common business and accounting policies and procedures for the many NASA wind tunnel facilities. Langley will coordinate the development and track common metrics and facilitate integrated wind tunnel scheduling for the primary facilities. Langley will coordinate the development of plans for integrated wind tunnel requirements to meet internal and external needs and assess those requirements against existing capabilities. Based on the assessment, recommendations for facility upgrades and maintaining facility investment plans will be made. Langley will coordinate the development and advocacy of strategic facility-related research program and funding plans to ensure world class capability for the United States well into the future.

Agency Support Activities

Program Manager for Non-Destructive Evaluation

Langley maintains Agencywide strategic goals, high level technical infrastructure, specific development objectives, and key activities for the Non-Destructive Evaluation (NDE) Program. Each Strategic Enterprise benefits from the NDE Program by the intrinsic technical and financial synergistic benefits of an Agencywide program focused on mission critical issues and enhanced safety, reliability, and mission success. The NDE Program provides an advisory and education forum that promotes Agencywide cooperation on mission critical issues, ensures the integrity of NDE processes, and educates the NASA community about the capability and applicability of NDE technologies. A NASA NDE Working Group (NNWG) was formed and has developed a strategic plan. The NNWG Strategic Plan is responsive to the budget, identifies what is needed to meet imposed requirements, and identifies the intercenter research and development activities necessary to evolve technologies and capabilities.

Lead for Scientific and Technical Information

LaRC has been assigned the lead Center responsibility for the Agency Scientific and Technical Information (STI) Program. This program will capture and disseminate NASA STI and provide access to worldwide mission-related information for its customers. When possible and economical, this information will be provided directly to the desktop in full-text information. This STI will include printed and electronic material, work-in- progress information, lessons-learned data, research laboratory files, wind tunnel data, metadata, and other information from the scientific and technical communities that will ensure the competitiveness of U.S. aerospace companies and educational institutions.

Lead for Program/Project Management Initiative Training

LaRC has been assigned the lead Center responsibility for the Program/Project Management Initiative (PPMI), an Agencywide resource established to provide total team and individual support for the benefit of developing and maintaining world class practitioners of project management in advance of need. PPMI is responsible for providing the necessary training and educational materials, as well as supporting the professional development needs of people in project management. Due to major changes in NASA project management, PPMI will be responding to management requirements in a variety of ways. The major tasks that will represent the main thrust of PPMI products and services have been presented to, and supported by, the NASA Program Management Council Working Group (PMCWG).

Functional and Staff Areas

To successfully accomplish its missions, Langley has in place an effective structure to carry out essential functional and support staff activities. These are described in section VII of this Plan.

Programs, Projects, and Activities

A comprehensive list of current and future programs, projects, and activities at Langley is provided in appendix A of this Plan.

Contributions to the Strategic Enterprises

The LaRC program will concentrate primarily on the Aeronautics and Space Transportation Technology (ASTT) and the Earth Science (ES) Enterprise and will include synergistic efforts in Space Technology. LaRC activities in support of Human Exploration and Development of Space (HEDS) and Space Science (SS) will capitalize on the synergistic capabilities at the Center, will support primary programs in the other Enterprises and, where possible, will not significantly deplete the resources required for the ASTT and ES Enterprises efforts. Our core competencies, including specialized facilities, provide a unique national capability.

The LaRC ASTT program is a broad-based effort spanning the complete breadth of airframe systems. Since the Langley role includes technology development for the entire aircraft, this approach positions LaRC as a vital national resource serving inherent government functions such as safety, national defense, the environment, and the national airspace system, and providing competitive technologies to U.S. industry.

The LaRC Atmospheric Sciences program is an Agency mission assignment that is conducted in collaboration with other Centers, other government agencies, and the international research community and will continue to focus on Earth radiation budget and atmospheric chemistry and dynamics.

Langley will develop Space Technologies in support of the Atmospheric Sciences program and the Space Science Crosscutting Technology Program. We will develop spaceframe technologies that are synergistic with our airframe systems capabilities.

Our success will be measured by the extent to which our research results and technologies contribute to the design, development, and operation of future aerospace vehicles and missions and the extent to which our scientific research contributes to the understanding of human-induced climatic and environmental change. Langley will enhance the value of aerospace technologies by promoting technology transfer and commercialization by nonaerospace industries.

Section I

Specific Roles in Support of Aeronautics and Space Transportation Technology Enterprise

The Aeronautics and Space Transportation Technology (ASTT) Enterprise has set bold objectives that are precompetitive research endeavors in long term, high risk, high payoff technologies that the private sector cannot afford to address due to the scale, risk, and duration of the tasks. These goals reflect national priorities for aeronautics and space as outlined by the National Science and Technology Council and in the National Space Policy. Langley plays a pivotal role in the ASTT technology goals that are framed in terms of the anticipated benefit of technology developed by NASA that will be incorporated by industry in future aeronautics and space transportation systems. With a strong partnership among industry, government, and academia, our history of innovation and technological breakthroughs will continue as we enter the 21st century. The responsible Program Office or point of contact for each LaRC objective is indicated within the brackets. Other Centers with a lead or major role are also listed. *The fiscal year of completion and the performance target number are indicated in parentheses.*

ASTT Enterprise Near-Term Goal 1

Global Civil Aviation—Enable U.S. leadership in global civil aircraft through safer, cleaner, quieter, and more affordable air travel.

ASTT Objective 1.1—Environmental Compatibility

Reduce the emissions of future aircraft by a factor of three within 10 years and by a factor of five within 25 years.

Reduce the perceived noise levels of future aircraft by a factor of two from today's current subsonic aircraft noise levels within 10 years, and by a factor of four within 25 years.

ASTT Performance Targets (FY 99)

1.1.1 Demonstrate an advanced turbine-engine combustor

LaRC Commitments Including Contributions to Enterprise Performance Targets

Exploit advanced smart systems concepts to improve drag, aeroelastic stability, and airframe noise [ASPO].

- Demonstrate a 30 percent reduction in wing bending loads, 3 dBA noise reduction with no weight increase, and a 15-percent decrease in weight of high-lift system through breakthrough embedded technologies for active control.

Environmental Assessment—Develop a scientific basis for assessment of the atmospheric impact of subsonic aviation, particularly commercial aircraft cruise emissions [AST/GSFC].

- Complete application of computer models in support of environmental assessment reports (FY99).
- Complete second program-level assessment report, leading to participation by PI's in preparation of 2000 UNEP/WMO ozone and Intergovernmental Panel on Climate Change (IPCC) climate assessment reports (FY99).
- Conduct third DC-8 Flying Laboratory field campaign for convective source measurements (FY99).

- Complete application of computer models in support of environmental assessment reports.
- Complete final program-level assessment report.

Emissions Reduction—Reduce the environmental impact of future engines by reducing NOx emissions during landing and takeoff cycle and during cruise operation. [AST/LeRC].

Noise Reduction—Provide technology to allow unrestrained market growth and compliance with international environmental requirements [AST/LeRC/ARC].

- Validate prediction and minimization methodology for community noise impact (FY99).
- Demonstrate 6 dB interior noise reduction relative to 1992 technology.
- Validate technology to reduce community noise impact by 10 dB relative to 1992 technology.
- Conduct large scale component validation of noise reduction technology.

ASTT Objective 1.2—Aviation Safety

Reduce the aircraft accident rate by a factor of five within 10 years, and by a factor of ten within 20 years.

ASTT Performance Targets (FY 99)

1.2.1 Characterize the Supercooled Large Droplets (SLD) icing environment.

1.2.2 Characterize the effect of SLD ice accumulation on aircraft performance.

1.2.3 Acquire data to support the development of SLD weather forecast tools.

1.2.4 For the aviation safety areas of controlled flight into terrain, runway incursion and loss of control, identify the contributing causes to be addressed, potential solutions using current capabilities, and gaps that require technology solutions.

LaRC Commitments Including Contributions to Enterprise Performance Targets

Develop and validate advanced technologies that reduce the aircraft accident rate from failure of aircraft controls, encounters with high intensity electromagnetic environments (EME), and failure of aging airframe structures [ASPO].

- Select display concept for synthetic vision for terrain awareness (low end) Plan (FY 99, T1.2.4).
- Prototype nondestructive evaluation inspection system for corrosion detection to measure thickness changes in thick section aircraft structures within 5 percent (FY 99).
- Develop integrated system ID, nonlinear modeling, and uncertainty modeling tool which will provide more efficient, easier design techniques for the development of complex control systems.
- Validate, design, and integrate concepts for EME immunity of digital avionics equipment, reducing the probability of aircraft system failures.
- Select robust control method(s) for use in integrated design methodology tool, providing more efficient, easier design techniques for the development of complex control systems.
- Optimize error-proof flight-desk design concepts with in-flight evaluation of advanced integrated displays which will decrease the likelihood of human errors and also the consequences of these errors if they are made.
- A complete, high quality database of mean and fluctuation quantities for computational fluid dynamics (CFD) validation studies and turbulence model evaluation (FY 99).

Single Aircraft Accident Prevention (SAAP)—Develop and support the implementation of technologies that go onboard an aircraft or have airborne system applications that will reduce the fatal accident rate [AvSPO].

- Complete certification plans and flight deck requirements for Synthetic Vision Precision Approach & Landing (PAL) systems onboard an aircraft.
- Complete development of a preliminary simulation database, mathematical models, and 6 degree of freedom (DOF) vehicle simulations to characterize adverse conditions, failures, and loss of control (LOC).
- Define and document requirements for onboard health management systems and for flight critical system design and validation.
- Perform concept demonstration of FAA ground based Runway Incursion Reduction Program technologies integrated onto an aircraft flight deck.
- Complete flight demonstration and provide documentation to support feasibility & certification criteria of Synthetic Vision display systems for eliminating low-visibility induced General Aviation accidents.
- Complete flight demonstration of Integrated Transport Synthetic Vision Display for eliminating low-visibility induced accidents.
- Enable implementation of standardized format for worldwide terrain and airport database information.
- Simulation and flight demonstration of integrated Health Management System & Fault Tolerant Integrated Modular Avionics (FTIMA).

Weather Accident Prevention (WAP)—Develop technologies that will provide high fidelity, timely and intuitive information to pilots, dispatchers, and air traffic controllers to enable the detection and avoidance of atmospheric hazards [AvSPO/LeRC].

- Operational in-service evaluation of national digital data link and graphical display of weather information.
- Demonstrate international capability for digital data link and graphical display of worldwide weather information.
- Demonstrate seamless multi-sensor based product for cockpit display of turbulence situation with certification supporting data.

Accident Mitigation (AM)—Develop, enable, and promote the implementation of technology that will increase the human survival rate in survivable accidents, and to prevent in-flight fires [AvSPO/LeRC].

- Develop and validate analysis tools for structural crashworthiness prediction.
- Develop advanced concepts to protect human body during crash: experimental verification of reduced *g*-loading performance of seat & restraint concepts.

System-Wide Accident Prevention (SWAP)—Address aviation safety issues associated with human error and procedural non-compliance through research in Human Error Modeling, Training, and Maintenance Human Factors [AvSPO/ARC].

- Simulation evaluation of candidate mitigation solutions demonstrating a reduction in error exposure.

Aviation System Monitoring and Modeling (ASMM)—Provide decision makers in air carriers, air traffic management, and other air services providers with regular, accurate, and insightful measures of the health, performance, and safety of the National Aviation System (NAS) [AvSPO/ARC].

ASTT Objective1.3—Affordable Air Travel

While maintaining safety, triple the aviation system throughput in all weather conditions within 10 years.

Reduce the cost of air travel by 25 percent within 10 years and by 50 percent within 25 years.

(Note: There are no ASTT Enterprise Performance Targets in FY 99 in Objective 1.3.)

LaRC Commitments Including Contributions to Enterprise Performance Targets

Develop, demonstrate, and validate advanced aeronautical concepts that lead to more affordable air travel through integrally stiffened fuselage structures, nonconventional aircraft designs, and advanced modeling and computational methods [ASPO].

- Demonstrate full-scale shape memory alloy (SMA) nozzle control feasibility at simulated operating loads leading to reduced weight of conventional mechanical systems without adding length to the nonvariable nozzle for a potential Direct Operating Cost + Interest (DOC+I) reduction of 2 percent for a commercial 4-engine wide body aircraft or 19 million gallon per plane per year fuel savings.

- Improve wind tunnel test capability/methodology by completing analysis of ground-to-flight corrections derived from National Transonic Facility (NTF) and CFD and comparing with flight data, experimentally validating design methodology on semispan unconventional configurations, and completing analysis of surface roughness studies.

Airframe Materials and Structures—Demonstrate and develop the scientific basis required for FAA certification of composite wing box structures that are 25 percent lighter and have a manufacturing cost of 20 percent less than current aluminum wing box structures [AST].

- Assemble the semispan wing and conduct Test Readiness Review (FY 99).

- Fabricate 10 replica of the semispan lower wing cover (FY 99).

- Verify, through semispan wing tests, that all load requirements are met (FY 99).

Airframe Methods and Design Environment Integration—Enhance the competitive position of the U.S. transport aircraft industry by delivering integrated design methodologies, new aerodynamic concepts, and faster design cycles [AST].

- Cruise multicomponent wing/propulsion airframe integration design tools calibrated (FY99).

- Demonstrate three-dimensional high-lift computational fluid dynamics methodology (FY 99).

Engine Systems—Reduce environmental noise and emission impacts by enabling geared, low noise fans with very high bypass ratios, improve cost competitiveness by reducing engine design cycle time, and improve engine durability [AST/LeRC].

Systems Evaluation—Provide credible assessments of the impact of alternative emerging civil aeronautics technologies on the integrated aviation system [AST].

- Release final Aviation System Analysis Capability (ASAC) (FY99).

Terminal Area Productivity (TAP)—Develop technologies and procedures enabling operation of the airport terminal area in instrument-weather, or nonvisual, conditions to safely match that of clear weather or visual conditions [ARC TAP-ASPO].

- Reduce landing approach spacing requirements with the aid of new sensors and procedures to detect and avoid wake vortex hazards of preceding aircraft.
- Develop technologies to improve flight crew and ground controller situation awareness of airborne traffic to enable reduced separation standards for closely spaced parallel runway operations.
- Develop and assess methods to integrate the ground based Center-TRACON Automation System (CTAS) with the airborne Flight Management Systems (FMS) of modern transports to improve operational efficiencies in the airport terminal area.
- Develop technologies and methods to improve the situation awareness of flight crew and ground controllers during low visibility landing and surface operations.
- Complete field demonstrations, including flight tests, to validate new concepts for terminal area capacity improvements and to promote the transfer of this technology into operational usage.

Advanced Air Transportation Technologies (AATT)—Develop technologies that will enable users of National Airspace System to operate with increased efficiency and to realize flexibility benefits possible under a future free-flight environment [ARC AATT-ASPO].

- Assess airborne flight system requirements for efficient operations in a free-flight environment.
- Develop, evaluate, and demonstrate the feasibility of airborne traffic avoidance concepts to aid in determining the appropriate mix of ground-based and airborne-based traffic management responsibilities.

Short-Haul/Civil Tilt Rotor (CTR)—Develop low-noise tilt rotor technology and flight procedures enabling community acceptance of civil tilt rotor aircraft through achievement of the FAA recommended criterion of 65 day-night sound level or less outside the area owned or controlled by the vertiport [ARC CTR-ASPO].

- Identify, analyze, and experimentally assess low-noise tilt rotor concepts.
- Develop and validate tilt rotor noise prediction and noise impact modeling methodologies.
- Develop and assess terminal area operational procedures for tilt rotors that minimize noise impact on the ground.

Enhanced Vision Sensor Technology and take off in low visibility weather conditions [DARPA-RTG].

- Perform flight demonstration tests of a Passive Millimeter Wave Camera to demonstrate the ability to see through weather.
- Evaluate applicability of enhanced vision sensor technology for low visibility surface operations during rollout and taxi flight segment, runway intrusion flight taxi situation, and Controlled Flight into Terrain (CFIT).
- Evaluate runway surface radiometric image enhancement techniques for low visibility flight conditions.

ASTT Enterprise Near-Term Goal 2

Revolutionary Technology Leaps—Revolutionize air travel and the way in which aircraft are designed, built, and operated.

ASTT Objective 2.1—High Speed Travel

Reduce the travel time to the Far East and Europe by 50 percent within 25 years, and do so at current subsonic ticket price.

ASTT Performance Target (FY 99)

2.1.1 Produce a complete vehicle system configuration document that includes impact of technology validation efforts from 1990 through 1999. Document will support the evaluation of technology selection decisions for a future HSCT.

LaRC Commitments Including Contributions to Enterprise Performance Targets

Aerodynamics and Flight Control—Complete studies by 2000 to support the development of an advanced supersonic cruise airplane with 33 percent more range and capable, with expected low-noise engine nozzles, of a 50 percent reduction in takeoff noise footprint [HSR].

- Complete wind tunnel and CFD evaluation of selected high-lift system on Technology Concept. Propulsion/airframe integration issues addressed along with powered ground-effects characteristics (FY 99, T2.1.1).
- Complete experimental and nonlinear computational inviscid and viscous assessment of the supersonic cruise and transonic cruise performance including the effects of aeroelastics on the Technology Concept (FY 99, T2.1.1).
- Aerodynamic performance and systems integration characteristics of final high-lift system configuration evaluated and verified through small- and large-scale model wind tunnel tests and supporting CFD analysis and systems integration studies.
- Complete experimental and nonlinear computational inviscid and viscous assessment of the supersonic cruise and transonic cruise performance, including the effects of aeroelastics on the Technology Configuration. Results include longitudinal and lateral/directional high speed stability and control characteristics and propulsion/airframe integration effects.

Materials and Structures—Develop wing and fuselage structural designs by 2002 that are 33 percent lighter than can be achieved with Concorde technology and have the durability to survive flight temperatures up to 350° F for 60,000 hours [HSR].

- Materials and structural concepts selected for wing and fuselage component test articles; selections based on material performance, structural efficiency, and production costs as determined by testing and analytical studies (FY 99, T2.1.1).
- Initial release of 1-lifetime of data acquired during accelerated thermal-mechanical fatigue testing of materials for use in validating analytical methods for predicting material degradation (FY 99).
- Make tollgate go/no go decision to proceed on to design of wing and fuselage components (FY 99).
- Selection of materials and structural designs for wing and fuselage of Final Technology Configuration.
- Delivery and preparation of wing and fuselage component articles for thermal, mechanical, and pressure testing.
- Release of materials database that has been validated by laboratory tests and analyses.
- Structural designs and computational methods for wing and fuselage validated through tests and analyses.

Flight Deck—Develop the necessary advanced systems and certification guidelines by 2001 for safe and efficient aircraft operations in the international airspace system [HSR].

- Basic External Visibility System concept evaluated in flight and simulation showing satisfactory performance and certification risk from visual through CATIIIb meteorological conditions at suitably equipped runways. Final NASA/Industry program selection of droop/no-droop configuration (FY 99).

- Final determination of satisfactory handling qualities, control response, and terminal area control performance in all flight and atmospheric conditions.

- Final design and flight test validation of full External Visibility System capability allowing satisfactory control and performance in CATIIIc conditions.

- Final definition and simulation validation of an HSR flight deck configuration following human-centered design principles and allowing enhanced operational capabilities and satisfactory performance in prime mission tasks.

Technology Integration—Merge the HSR technology developments into a complete vehicle system evaluation to measure the progress of technology development to support technology select decisions [HSR].

- Define an optimized NASA/Industry technology baseline airplane configuration resulting from HSR technology validation development and selection processes. Make final selection of technology elements for the airplane and embody these features in the baseline airplane definition. The selection process will allow scale-up of the chosen technology elements for large scale tests where appropriate. Technology validation and decisions include boom softening, SLFC, droop nose, propulsion system configuration, materials and design, flight deck, wing planform, high lift controls, and systems (FY99, T2.1.1).

- Define, document, and deliver to industry a NASA/Industry technology baseline airplane configuration that includes final, validated HSR II technology. Configuration will be environmentally acceptable and economically viable.

Environmental Impact—Extend and complete the efforts to define the critical HSCT environmental compatibility requirements in the areas of atmospheric effects, community noise, sonic boom impact, and atmospheric ionizing radiation to establish a technology foundation by 2002 to meet these requirements [HSR].

- Complete documentation on the evaluation of the FY 99 Technology Concept Airplane (TCA). A significant experimental database from both ground and flight tests will be available to enhance credibility and reduce the uncertainty of the assessment. Will produce a status report on certification rule development (FY99, T2.1.1).

- Prediction methodologies will incorporate databases developed. Define any operational procedures or routes required. Determine capability of Final Technology Configuration (FTC) to meet environmental standards, rules, and criteria.

Enabling Propulsion Materials—Provide materials by 2002 for the propulsion system that will meet the low emissions and low noise environmental requirements, while meeting the weight, performance, and durability requirements [HSR/LeRC].

Critical Propulsion Components—Develop the component technologies by 2002 for an advanced HSCT propulsion system which would be both environmentally compatible and economically viable (i.e., low nitrogen oxide emissions, low noise, high performance, and low specific fuel consumption) [HSR/LeRC].

Prepare technology risk reduction beyond HSR Phase II emphasizing full scale engine/nozzle demonstration tests [HSR/LeRC] and airframe materials and structures for viable low-cost manufacturing processes [HSR].

ASTT Objective 2.2—General Aviation Revitalization

Invigorate the general aviation industry, delivering 10,000 aircraft annually within 10 years, and 20,000 annually within 25 years.

ASTT Performance Targets (FY 99)

2.2.1 Complete assembly of the first flight-ready piston engine.

2.2.2 Complete preflight ground testing for the turbofan engine.

LaRC Commitments Including Contributions to Enterprise Performance Targets

General Aviation—Support revitalization of U.S. general aviation by developing and transferring technology to enhance small aircraft transportation system capabilities [AST].

- Complete assessments of current and latent markets and assess domestic and international benefits (FY99).
- Evaluate and select prototype systems for integrated testing (FY99).
- Simulation and flight test validated transportation system concepts.
- Publish design guidelines, system standards, and certification bases and methods.

ASTT Objectives 2.3 and 2.4—Next-Generation Design Tools and Experimental Aircraft

Provide next-generation design tools and experimental aircraft to increase design confidence and cut the design cycle time for aircraft in half.

ASTT Performance Targets (FY 99)

2.3.1 Conduct test flights to validate the proof-of-concept design for a solar electric remote piloted aircraft (RPA).

2.3.2 Initiate the development of an RPA capable of achieving an operational altitude of 100, 000 feet.

2.3.3 Initiate RPA flight demonstrations to validate the capability for science missions at 55,000 feet.

2.4.1 Demonstrate up to a 200-fold improvement over the 1992 baseline in time-to-solution for NASA's advanced applications on computational testbeds.

2.4.2 Demonstrate communication test beds with up to 500-fold improvement over the 1996 baseline.

LaRC Commitments Including Contributions to Enterprise Performance Targets

High Performance Computing and Communications Program—accelerate the availability of high performance computing hardware and software to the US aerospace industry for use in their design processes [HPCC].

- Demonstrate multidisciplinary design optimization of HSCT using high-fidelity modeling (FY 99, T2.4.1).
- Implement design-oriented advanced high-fidelity codes, including sensitivity calculations, on a massively parallel testbed.
- Develop parallel rendering algorithms, parallel library interfaces, and associated software infrastructure to support visualization applications on distributed-memory computer architectures (FY 99).

Tools and Test Techniques that overcome barrier technology issues on a broad range of airframe systems [ASPO].

- Provide validated design criteria for out-of-control “falling-leaf” observed for the F-18 aircraft under high angle-of-attack maneuvers.
- Demonstrate Multi-Disciplinary Optimization (MDO) approximation tools for non-linear problems and static aero/structural optimization by reducing number of cycles by a factor of 10.
- Develop robust viscous adaptive grid technology which enables 1 CFD run per day

for an advanced stealthy high-performance aircraft.

- Demonstrate reliable use of CFD methods for stability and control derivatives in early design with reliance on CFD methods.
- Demonstrate a reduction of 2 orders of magnitude in design iterations by integrating high fidelity aerodynamic, structural, and aeroelastic optimization methods.
- Identify advanced vehicle concepts by assessing their potential benefits and determining the technologies that are required for development.

High Performance Aircraft—Reduce the design time for military aircraft and enhance aircraft operability and survivability [ASPO].

- Define aeroelastic characteristics for Active Aeroelastic Wing (AAW) flight vehicle with potential 7–10 percent reduction in wing weight (FY 99).
- Increase F/A-18 vertical tail fatigue life by a factor of 10 or higher for current and future high-performance aircraft (FY 99).
- Support Joint Strike Fighter (JSF) Program by providing STOVL jet effects tests, hover tests, low- and high-speed inlet tests, static and forced oscillation stability and control tests, rotary balance tests, free spin test, exhaust nozzle calibrations, propulsion system ducting pressure loss and flow characterization, and piloted flight simulations.
- Demonstrate advanced, nonlinear optimal control law design for a wide variety of unconventional control effectors for unstable high-performance aircraft.

Hyper-X—Develop and demonstrate, with ground and flight tests from Mach 5 to Mach 10, the methods and tools for conceptual design and performance predictions of hypersonic aircraft with an airframe-integrated dual-mode scramjet propulsion systems [ATTO/DFRC].

- Demonstrate an airframe integrated, dual-mode scramjet-powered vehicle in flight at a Mach number of 7.
- Demonstrate an airframe integrated, dual-mode scramjet-powered vehicle in flight at a Mach number of 10.

ASTT Enterprise Near-Term Goal 3

Access to Space—Enable the full commercial potential of space and expansion of space research and exploration.

ASTT Objective 3.1—Space Launch Technologies

Reduce the payload cost of low Earth orbit by an order of magnitude, from $10,000 to $1,000 per pound, within 10 years and by an additional order of magnitude, from $1,000 to $100’s per pound, within 25 years.

ASTT Performance Targets (FY 99)

3.1.1 Complete the X-33 in preparation for flight testing.

3.1.2 Begin flight tests of the X-34 and demonstrate key technologies for reducing the cost of space transportation.

LaRC Commitments Including Contributions to Enterprise Performance Targets

X-33, X-34, and RLV—Develop and demonstrate technologies for the X-33 and X-34 in aerothermodynamics, structures, materials, and vehicle systems in support of industry partners for successful flight testing in 1999 and for the validation of Reusable Launch Vehicle (RLV) technologies [MSFC-RLV-ATTO].

- Support X-33 and X-34 flight system development and flight test planning. Assist in postflight test results analysis to validate analytical tools and technologies in support of the operational RLV and future launch vehicle developments [MSFC-RLV-ATTO] (FY 99, T3.1.1 and 3.1.2).

- Provide the aerodynamic and aerothermodynamic analyses and develop the detailed databases required for development of advanced space transportation systems [ATTO].
- Support vehicle configuration design and maturation of the “Venture Star” operational RLV to meet mission operational and flight design requirements. [ATTO].
- Develop structures and materials for RLV's, including composite materials for primary structures and cryotanks, durable and operable metallic thermal protection systems, and refractory composite materials [ATTO].

Space Launch Technology—Develop low cost space launch technologies.

- Develop and assess advanced space access vehicle concepts which meet projected mission, operational, and affordability requirements by identifying systems sensitivities, technology requirements, and benefits to support future investment decisions [ATTO].
- Demonstrate and validate the technology and the experimental and computational methods and tools for design and performance predictions for an airframe-integrated scramjet- powered Mach 10 configuration (Hyper-X) by 2001 [ATTO].
- See Hyper-X milestones under Objective 7.3 and 7.4.
- Develop experimental databases and conceptual designs of combined air-breathing and rocket propulsion systems. Expand test and analysis capabilities to support propulsion flow path and vehicle configuration studies [ATTO].
- Support the configuration development of advanced space transportation systems through both experimental and analytical aeronautical and aerothermodynamic studies [ATTO].
- Exploit the synergy of aeronautics technology programs in advanced lightweight, high-temperature metallic and composite materials, structural concepts and analysis, low-cost manufacturing), and computational fluid dynamics [ATTO].
- Note: Additional milestones are being developed as part of the Space Transportation Technology Program NRA process [ATTO].

ASTT Service Goal 4

Research and Development (R&D) Services—Enable, and as appropriate, provide on a national basis, world-class aerospace R&D services, including facilities and expertise, and proactively transfer cutting-edge technologies in support of industry and U.S. Government R&D.

ASTT Objective 4.1

World-class aerospace research and development services, facilities, and expertise.

ASTT Performance Targets (FY 99)

4.1.1 Complete 90 percent of Enterprise aggregate deliverables within three months of schedule.

4.1.2 Achieve a facility utilization customer satisfaction rating of 95 percent of respondents at 5 or better and 80 percent at 8 or better.

4.1.3 Achieve an overall Enterprise customer satisfaction rating of 90 percent.

4.1.4 Transfer at least 10 new technologies and processes to industry.

4.1.5 Facilitate the replication of the Mobile Aeronautics Education Laboratory.

4.1.6 For all new program activities initiated in FY 99, develop an education outreach plan, which includes and results in an educational product.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Develop implementation strategies for continued access by industry and other government agencies to Langley R&D services, facilities and expertise.
- Complete at least 90 percent of all Enterprise-controlled scheduled milestones within three months of their planned date (FY 99, T4.1.1).
- Achieve a facility utilization customer satisfaction rating of at least 95 percent at 5 or better and an overall average of 9 out of 10 (FY 99, T4.1.2).
- Continue an active program of transferring technology to the aerospace and non-aerospace community. Have 90 Space Act Agreements in place by the end of FY 99 facilitating active technology transfer interactions between LaRC and our industry partners. Establish a Business Incubator which will facilitate signing of new license agreements (FY 99, T4.1.4).
- Begin operation of a mobile Aeronautics Education Laboratory (to be provided by Lewis Research Center) (FY 99, T.4.1.5).

Section II

Specific Roles in Support of Earth Science Enterprise

The Earth Science (ES) Strategic Plan provides for an understanding of the total Earth system and the effects of natural and human-induced changes on the global environment from space-based and in situ capabilities that will yield new scientific information that is of practical use to national decision makers. Langley plays an important role in the ES program by providing key atmospheric science information and contributing to the Enterprise Goals in significant ways. *The fiscal year of completion and the performance target number are indicated in parentheses.*

ES Enterprise Near-Term Goal 1

Expand scientific knowledge by characterizing the Earth system.

ES Performance Targets (FY 99)

1.0.1 Successfully launch four spacecraft, within 10 percent of budget on average.

ES Objective 1.1

Understand the causes and consequences of land-cover/land-use change.

ES Performance Targets (FY 99)

1.1.1 Refresh the global archive of 30 m land imagery from Landsat 7.

1.1.2 Collect near-daily measurements of the terrestrial biosphere.

1.1.3 Collect near-daily measurements of ocean color.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Construct a 15-year survey of burned areas through the use of Advanced Very High Resolution Radiometer (AVHRR) imagery for the entire boreal forest. Quantify the interannual variations in fire activity (T1.1.2).
- Develop graphical maps of tropical fire patterns, determine the interannual variations in those patterns, and develop fire-activity models for the construction of an aerosol climatology for the Surface Radiation Budget (SRB) and the Clouds and the Earth's Radiant Energy System (CERES) projects (T1.1.2).
- Analyze existing satellite measurements and develop new techniques and procedures to determine the geographical and temporal distribution of biomass burning, a major process of land cover change for the Global Tropospheric Experiment (GTE), CERES, and SRB programs (T1.1.2).
- Use the Lidar Atmospheric Sensing Experiment (LASE) to study the influence of soil moisture on atmospheric boundary layer (ABL) development as part of the Southern Great Plains (SGP'97) experiment (FY 99).

ES Objective 1.2

Predict seasonal-to-interannual climate variations.

ES Performance Targets (FY 99)

1.2.1 Begin the second of a three-year sequence of instantaneous measurements of rainfall rates and monthly accumulations in the global tropics.

1.2.2 The QuickScat spacecraft will provide wind speed and direction measurements over at least 90 percent of the ice-free global oceans every two days.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Continue analysis of passive Stratospheric Aerosol and Gas Experiment (SAGE, SAGE II, and SAGE III) and active Lidar In-space Technology Experiment (LITE) spaceborne remote sensing data on global cloud distributions to improve understanding of radiative effects on seasonal-to-interannual time scales.
- Continue development and utilization of the LaRC IMPACT (Interactive Modeling Project for Atmospheric Chemistry and Transport) model, a state of the art three-dimensional atmospheric simulation model with fully coupled radiation, chemistry, and dynamics. Use this model to study annual and interannual variability in ozone, water vapor, and key constituents in the lower stratosphere and upper troposphere associated with natural changes in polar stratospheric clouds (PSC) processing, aerosol loading, quasi-biennial oscillation, and the El Nino-Southern Oscillation.
- Utilize the LaRC IMPACT model to assess long term (decade or longer) impacts on the Earth's atmosphere from both natural and anthropogenic changes. (CO_2, CH_4, CFC's emissions from projected socio-economic development and NOx, SO_2 and H_2O emissions associated with the proposed fleet of commercial high speed aircraft).
- Conduct studies of infrared and visible climate forcing from the Mount Pinatubo aerosol cloud with advanced radiative transfer models and aerosol data derived from observations from Langley's Halogen Occultation Experiment (HALOE). These studies will assess the magnitude of short-term climate forcing from natural phenomena.
- Monitor interannual and seasonal cycles of atmospheric gases by recording and analyzing high-resolution infrared spectra at Network for the Detection of Stratospheric Change (NDSC) and complementary sites (e.g., Kitt Peak).
- Using LASE data obtained in the 1996 Tropospheric Aerosol Radiative Forcing Experiment (TARFOX), perform calculations of atmospheric radiative forcing (FY 99).
- Conduct studies to define scientific requirements and to assess the availability of the technology required for the development of a geostationary satellite instrument capable of observing, with high vertical resolution, atmospheric temperature and moisture profiles and the concentration distribution of radiatively active trace gases with the time and space resolution required for process and transport detection.
- Develop scientific algorithms for retrieving the desired atmospheric variables from the radiometric observations specified for the Geostationary Atmospheric Sounder (GAS).
- Conduct theoretical and airborne studies with newly available Fourier transform Interferometers to empirically validate the ability to achieve the scientific requirements of the GAS.
- Develop laboratory, balloon-borne, and airborne technology demonstration models which can be used to validate the engineering approach defined for the GAS.
- Develop the GAS for an NMP EO-3 mission from a geostationary satellite platform developed for either commercial broadcast, scientific research, or operational weather observation applications.
- Develop the high speed data processing and environmental product display system required for the production, dissemination, and utilization of GAS observations.
- Provide GAS products to the ES scientific research community and to National

Oceanic and Atmospheric Administration (NOAA) in near real time, for demonstrating the operational utility of the data.

- Using the National Polar Orbiting Environmental Satellite System (NPOESS) Airborne Sounder Testbed-Interferometer (NAST-I) participate in airborne field programs of the NASA ER-2 to obtain radiometric measurements which can be used to simulate infrared sounder observations proposed to be achieved from the NPOESS.
- Develop methods for retrieving surface and atmospheric variables (i.e., NPOESS EDR's) from the airborne NAST-I data. Test these methods with both theoretical simulations of NPOESS infrared and microwave sounding data, as well as airborne measurements with the NAST.
- Using in situ and remote sensing data obtained from ground truth sites (e.g., the DoD Cloud and Radiation Testbed (CART) sites), as well as other airborne and satellite sensors, experimentally validate the ability to achieve the specified goals of the NPOESS sounding system using the NAST-I and NAST-M (microwave) data obtained during airborne missions of the ER-2.
- Using the NAST data sets obtained for a variety of surface and atmospheric conditions and climatological regimes, improve the product retrieval algorithms and the instrument specifications to optimize the NPOESS global sounding performance.
- Prepare and disseminate data sets for NPOESS contractors and Operational Algorithm Team (OAT) members that can be used to test data processing procedures developed for the NPOESS sounding instruments.
- Infuse new instrument and data processing technology developed at LaRC into the NPOESS sounding instrument program.

ES Objective 1.3

Identify natural hazards, processes, and mitigation strategies for floods, droughts, and volcanoes.

ES Performance Targets (FY 99)

1.3.1 The Enterprise will provide the technology and instruments to collect Synthetic Aperture Radar (SAR) data which will provide data sufficient to create a digital topographic map of 80 percent of the Earth's land surface.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Analyze cloud and radiation data sets to improve our understanding of phenomena such as El Nino events that can lead to widespread droughts, floods, and severe weather.
- Analyze the global and regional effects of volcanic eruptions in changing the climate. Determine changes in cloud physical properties due to volcanic aerosols.
- Work with the Aviation Safety Program to develop strategies for monitoring volcanic ash clouds and delivering ash cloud hazard information to commercial and private pilots.
- Work with the Aviation Safety Program to develop strategies for characterizing atmospheric turbulence, for predicting aircraft icing conditions, and for delivering this information to pilots and ground control.
- Coordinate space-based fire detection activities with the U.S. Forest Service (USFS), Bureau of Land Management (BLM), Department of Defense (DoD), Department of Interior (DoI), National Oceanic and Atmospheric Administration (NOAA), and Environmental Protection Agency (EPA).

ES Objective 1.4

Detect long-term climate change, causes, and impacts

ES Performance Targets (FY 99)

1.4.1 Conduct daily observations of cloud properties such as extent, height, optical thickness, and particle size.

1.4.2 Map aerosol formation, distribution, and sinks over the land and oceans.

1.4.3 Achieve a 40 percent reduction in the uncertainty in the Earth's radiation balance.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Launch two Clouds and the Earth's Radiant Energy System (CERES) instruments on the first Earth Observing System (EOS) spacecraft to globally monitor the Earth's radiant energy system in conjunction with the Moderate Resolution Imaging Spectroradiometer (MODIS) scanning spectrometer for improved measurement of cloud physical properties (FY 99, T1.4.1, T1.4.3).
- Analyze results from the two CERES scanners to allow the development of a new class of models for the anisotropy of the shortwave and long wave radiation fields (T1.4.3).
- Conduct follow-on field experiments similar to the First International Satellite Cloud Climatology Project (ISCCP) Regional Experiment (FIRE), Global Energy and Water Cycle Experiment (GEWEX) Continental-Scale International Project (GCIP), Baseline Surface Radiation Network (BSRN), and Atmospheric Radiation Measurement (ARM) programs to perform cloud and radiation process studies and to validate satellite-derived data sets (T1.4.3).
- Analyze Tropical Rainfall Measuring Mission (TRMM) data, including the first simultaneous measurements of clouds from the Visible Infrared Scanner (VIRS) imager, cloud liquid water (passive microwave), rainfall (active and passive microwave), and radiation budget (CERES broadband scanner). These measurements will allow the first combined examination of the latent heat and radiative heat terms which dominate the atmospheric energy budget in the tropics (T1.4.3).
- Use CERES data to improve parameterizations of clouds and radiation in climate prediction models (T1.4.3).
- Continue Earth Radiation Budget Experiment (ERBE) nonscanner measurements to extend the 13-year record of top-of-atmosphere boundary conditions to determine climate variability (T1.4.3).
- Develop a long term database of the Earth's reflected and emitted radiation to establish a baseline for assessing global change (T1.4.3).
- Develop parameterizations of radiative effects of trace gases in the atmosphere. Trace gases are important in assessing climate change and in obtaining accurate retrievals from Earth-viewing satellite instruments (T1.4.3).
- Perform analysis of long term global satellite observations and in situ high resolution aircraft measurements in conjunction with Lagrangian photochemical modeling to characterize and understand long term variations in chemically and radiatively active trace gas composition in the middle and lower stratosphere.
- Extend multidecadal data records on climatically important aerosols, ozone, and water vapor obtained from ground-based lidar and spaceborne solar occultation sensors (SAGE and SAGE II) (T1.4.2).

- Monitor long term trends and latitudinal variations of atmospheric gases by recording and analyzing high-resolution infrared spectra at NDSC and complementary sites (e.g., Kitt Peak).

- Participate in efforts to improve calibration between NDSC instruments and between sites.

- Complete validation of CERES scanner measurements for inter-decadal comparisons with ERBE scanner measurements to detect regional and global climate changes (T1.4.3).

- Reprocess 5-year history of ERBE scanner measurements from three satellites with improved CERES algorithms for more accurate inputs to climate models (FY 99).

- Extend the long term radiation database with results from CERES instruments on future orbital missions (e.g., TRMM, EOS-AM, EOS-PM) (T1.4.3).

- Acquire new spectroscopic data sets for minor trace species for incorporating into radiative transfer models to examine the effects on satellite retrievals and climate.

- Conduct long term simulations with a fully coupled, three-dimensional atmospheric model with time-dependent aerosol loading and source gas emissions for comparison with observed long term behavior to evaluate the ability of atmospheric models to simulate the combined effects of chemical and transport processes on atmospheric chemical composition.

ES Objective 1.5

Understand the causes of variation in ozone concentrations and distribution in the upper and lower atmosphere.

ES Performance Targets (FY 99)

1.5.1 Total Ozone Mapping Spectrometer (TOMS) will use new retrieval methods to collect and analyze three new data products.

1.5.2 SAGE III will provide measurements of the distribution of trace constituents, temperature, aerosols, and cloud presence.

1.5.3 Complete the major model-measurement intercomparison for atmospheric chemistry/transport models.

1.5.4 Complete the detailed multiaircraft study of tropospheric chemistry over tropical Pacific Ocean.

1.5.5 Measure surface levels of chlorine- and bromine-containing chemical compounds addressed under the Montreal Protocol.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Obtain and validate initial aerosol, ozone, nitrogen dioxide and trioxide, and chlorine dioxide measurements with the EOS SAGE III instrument on the Russian (Mesosphere-Thermosphere Emissions for Ozone Remote Sensing (METEOR) 3M mission (FY 99).

- Using Lagrangian trajectory and photochemical models in conjunction with analysis of satellite observations, provide a large-scale perspective of transport and photochemical processes in the lower stratosphere to complement high-altitude ER-2 aircraft investigations (ASHOE/MAESA, STRAT, POLARIS) designed to examine ozone loss in the Southern Hemisphere polar vortex, the morphology of long-lived tracers, and the photochemical evolution of polar stratospheric ozone in the Northern Hemisphere summer (T1.5.4).

- Utilize three-dimensional atmospheric simulation models with fully coupled radiation, chemistry, and dynamics to study annual and interannual variability in ozone, water vapor, and key constituents in the lower stratosphere and upper troposphere due to natural changes, including PSC (Polar Stratospheric Clouds) processing, aerosol loading, quasi-biennial oscillation, and the El Nino-Southern Oscillation (T1.5.4).

- Determine the geographical and temporal distribution of the gaseous emissions from biomass burning which lead to the photochemical production of tropospheric ozone or to the chemical destruction of stratospheric ozone.

- Analyze and document in situ and remote measurements of aerosols, ozone, and other related trace species and processes in the troposphere that were obtained during Global Tropospheric Experiment (GTE) missions to develop a substantial understanding of human impacts on the chemistry of the global troposphere.

- Analyze the transport of ozone and ozone precursors from biomass burning and urban sources to remote, relatively pristine oceanic regions. Determine the tropospheric processes by which ozone and ozone precursors are vertically mixed within the atmosphere (FY 99 for Pacific Exploratory Mission (PEM**)** **-** Tropics A).

- Continue high vertical resolution, near-global measurement record of ozone, aerosols, and nitrogen dioxide from SAGE II.

- Develop improved algorithms for processing SAGE I and SAGE II measurements to better quantify long term global trends and variability in ozone and aerosols.

- Use SAGE II multiwavelength extinction measurements to estimate stratospheric aerosol surface area and volume distributions for use in parameterizing ozone-destructive heterogeneous chemical processes in global photochemical models.

- Use LITE and SAGE data to study the distribution and variability of aerosols in the upper troposphere, including those produced by biomass burning, to aid in assessing their impact on tropospheric ozone.

- Record high resolution atmospheric infrared spectra over broadband passes to obtain simultaneous measurements of many species (from ground, balloon, and space).

- Use the LaRC airborne UV DIAL system in NASA missions to measure distributions of aerosols and ozone in atmospheric chemistry and dynamics missions and in validation studies for new space-based ozone-measuring instruments.

- Continue to develop and enhance satellite data analysis techniques for producing tropospheric ozone distribution products from existing NASA satellite instrument data sets.

- Participate in high-altitude ER-2 field campaigns in support of SAGE III and EOS AM-1 validation efforts by providing trajectory mapping capabilities for comparison between in situ and multiple satellite observations of ozone, aerosols, and other key species primarily involved in ozone production and loss processes (T1.5.2).

- Expand the capability of the LaRC IMPACT model to simulate chemical processes in the troposphere to include wet and dry deposition, global source inventories of NOx emissions, and tropospheric hydrocarbon chemistry using modified chemistry algorithms which have been compared with consensus results from a recent Intergovernmental Panel on Climate Control (IPCC) photochemical model comparison (T1.5.3).

- Extend current studies of climate forcing from stratospheric aerosols to study the role of stratospheric ozone variability in climate forcing. This work will use long-term data sets gathered by SAGE and HALOE with advanced radiative transfer routines and should eventually be included in international assessments of radiation and climate.

- Develop the following improved sensor systems and techniques for the measurement of concentrations and fluxes of tropospheric trace species: 1) three-dimensional hot wire sensor for microwave turbulence measurements, and 2) NH_3 airborne sensor.
- Conduct GTE PEM Tropics B airborne studies to determine 1) convective transport of tropospheric species, 2) production of NOx by lightning, 3) gas to particle conversion processes, and 4) trace species exchange over ocean upwelling and globally important ecosystems (FY 99, T1.5.4).
  - ❍ Manage and direct field experiments to improve our understanding of the role of clouds in climate and climate change (FIRE), and to contribute to the scientific understanding of human impacts on the chemistry of the global troposphere (GTE).
- Develop high-speed data acquisition, analysis, and display systems for measurement of trace gases and turbulent air motions from aircraft.
- Continuous improvement of capabilities to obtain information on more species from atmospheric spectral data, including measurement and analysis of laboratory spectra where needed.
- Develop a differential absorption lidar system to measure both stratospheric and tropospheric ozone and aerosols from space. A future space-based ozone and aerosol lidar system, called the Ozone Research and Advanced Cooperative Lidar Experiments (ORACLE) to be developed jointly by NASA and the Canadian Space Agency. The initial demonstration experiment will be conducted from the shuttle as part of the New Millennium Program.
- Improve characterization of the global ozone distribution (stratospheric and tropospheric) and of long-term changes in this distribution by the use of existing and planned satellite data sets. Enable determination of mesoscale structure in total ozone field, as well as a monitoring capability for tropospheric pollution formation and transport, through implementation of geostationary observations.

ES Enterprise Near-Term Goal 2

Disseminate information about the Earth system.

ES Objective 2.1

Improve dissemination of Earth Science research results.

ES Performance Targets (FY 99)

2.1.1 Make available data on prediction, land surface, and climate users within five days.

2.1.2 Double the volume of data archived compared to FY 97.

2.1.3 Increase the number of distinct customers by 20 percent.

2.1.4 Increase products delivered from the Distributed Active Archive Center (DAAC) by 10 percent.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Provide processing, archival, and distribution of data from CERES, Multi-Angle Imaging Spectro-Radiometer (MISR), and Measurements of Pollution in the Troposphere (MOPITT) instrument on the 1999 EOS AM-1 mission (FY 99).

- Provide processing, archival, and distribution of data from the SAGE III experiment on the initial 1999 Russian METEOR 3M mission (FY 99).
- Develop Pathfinder data sets from satellite-based measurements, including cloud physical and microphysical properties, shortwave and long wave radiative fluxes, and clear-sky radiative properties. Use the data sets to evaluate effectiveness of system structures.
- Provide improved World Wide Web search interface for CERES data products (T2.1.4).
- Provide results from the EOS Data and Information System (EOSDIS) Community Cost Model to allow evaluation of costs for alternative architectures.
- Distribute SAGE standard data products (e.g., aerosol extinction, ozone, and cloud occurrence) on a continuing basis through the LaRC DAAC (T2.1.4).
- Distribute SAGE higher-level aerosol data products (e.g., global optical depth and surface areas) via Internet home page.
- Complete development of publicly available (through LaRC DAAC (Distributed Active Archive Center)) archive of climatically important global aerosol and cloud data from the 1994 Shuttle-based LITE (FY 99).
- Advertise and distribute GTE data through the World Wide Web.
- Archive and Distribute LITE level 1 data products through the LaRC DAAC (FY 99, T2.1.4, T2.1.2, T2.1.3).
- Provide global data sets on the Earth's radiation budget through the LaRC DAAC and the EOSDIS (T.2.1.2, T2.1.4).
- Provide subsetting and indexing capability for CERES data products that will allow users to find data for specialized needs.
- Develop airborne UV DIAL and LASE data images (e.g., atmospheric cross sections of ozone, water vapor, aerosols, and clouds) via Internet home page and digital data via LaRC DAAC and other field experiment data archives via CD's (T2.1.4).

ES Objective 2.2

Incorporate education and enhanced public understanding of science as an integral component of Earth Science missions and research.

ES Performance Targets (FY 99)

2.2.1 Award 50 new graduate student research grants.

2.2.2 Award 20 early career fellowships in Earth Science.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Prepare educational exhibits on LaRC atmospheric sciences research and accomplishments for state fairs, science fairs, special tours, and museum displays.
- Create a document on LaRC research activities and accomplishments in the atmospheric sciences for public distribution.
- Develop and administer EDCATS forms for outreach programs.
- Provide unique and innovative materials electronically via the World Wide Web that explain SAGE II, SAGE III, LITE, CERES, and other ES projects and why they are important to our understanding of climate and atmospheric chemistry.
- Implement a World Wide Web data search and order system that encourages general

access to the broad range of data and information at the LaRC DAAC.

- In partnership with LaRC Office of Education and educators, develop specialized products that enable educators to incorporate atmospheric science concepts into their classrooms.
- Organize and coordinate Earthwatch summer research camps.
- Mentor high school and college students (undergraduate and graduate) through the Office of Education summer programs.
- Support GLOBE (Global Learning and Observations to Benefit the Environment). Implement a GLOBE project for school participation in the validation of tropospheric ozone measurements.
- Continue to develop the Students' Cloud Observations On-Line (S'COOL) program for educational outreach to involve students, both national and international, in ES research and promote interest in science. Expand the program to include senior citizen groups.
- Make tropospheric trace species information and assessments accessible to ES information customers, including the general public, media, publishers, and industry.
- Collaborate with LaRC Office of Education and the Learning Technologies Project (LTP) in development of innovative distance learning projects for precollege audiences.

ES Enterprise Near-Term Goal 3

Enable the productive use of Earth Science and technology in the public and private sectors.

ES Objective 3.1

Make major scientific contributions to national and international environmental assessments.

ES Performance Targets (FY 99)

3.1.1 Contribute to the Atmospheric Effects of Aviation.

3.1.2 Contribute to the U.S. regional/national assessment(s) in partnership with USGCRP agencies.

3.1.3 Contribute to the World Meteorological Organization Ozone Assessment.

3.1.4 Contribute to the Intergovernmental Panel on Climate Change Report.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Analyze measurements of aircraft emissions (Subsonic Assessment (SASS) project) to determine their impact on the environment. Participate in test program to evaluate dry aerosol measurements techniques for SASS applications (FY 99).
- Contribute results of climate process studies and fundamental observations of radiative forcing and feedback to the IPCC for assessment studies (T3.1.4).
- Develop a Northern Hemisphere climatology of contrail coverage using geostationary and sun-synchronous satellite data. Examine changes in cloudiness due to contrails and compute their impact on the radiation budget (T3.1.1).
- Provide a large-scale prospective of atmospheric transport and chemistry for assessments of potential effects of stratospheric aircraft during ASHOE/MAESA and POLARIS high-altitude ER-2 aircraft investigations by combining remote satellite and in situ observations of ozone and other key species through Lagrangian trajectory/photochemical modeling.
- Contribute SAGE and lidar data on aerosols and ozone, and serve as lead and contributing authors to the 1998 United Nations

Environment Programme/World Meteorological Organization (UNEP/WMO) international ozone assessment (T3.1.3).

- Use the airborne DIAL system to study the impact of civil aircraft emissions on ozone concentrations, the impact of biomass burning on aerosol and ozone distributions, and the global climate change (T3.1.1).
- Conduct long term, coupled, three-dimensional atmospheric radiation, chemistry, and dynamics simulations for comparison with two-dimensional assessment model simulations for Atmospheric Effects of Aviation Project (AEAP) and IPCC assessments (T3.1.1, T3.1.4).
- Contribute data and provide authorship and reviews to future assessments of the potential atmospheric effects of supersonic and subsonic aircraft (T3.1.1).
- Using the LASE instrument, participate in future regional, national, and international field experiments to study cirrus clouds, upper tropospheric water vapor, and the Arctic and Antarctic stratosphere. Provide ozone measurements, modeling, and analysis in support of the Intergovernmental Panel on Climate Change's periodic reports.

ES Objective 3.2

Develop innovative technologies for Enterprise missions and for transfer to external customers.

ES Performance Targets (FY 99)

3.2.1 Achieve an 80 percent reduction in mass for future land imaging instruments.

3.2.2 Demonstrate a new capability to double the calibration quality for moderate resolution land imagery.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Contribute to the generation, update, and review of the ES Technology Investment Plan through membership in the Technology Strategy Team.
- Continue design of a passively cooled infrared emission limb sounder capable of measuring stratospheric temperature and ozone. Passive cooling removes significant cost and risk associated with active cryocoolers and allows for long instrument life.
- Apply advanced technology in the area of Fourier transform spectrometry (FTS) to sense cirrus cloud ice content and ice water path.
- Develop and transfer to industry advanced (e.g., Gas and Aerosol Monitoring Sensorcraft (GAMS)) technologies for low-cost solar-occultation measurements of atmospheric constituents.
- Explore advanced sensor concepts for radiation budget, including sensor arrays and highly absorbent coatings.
- Develop advanced DIAL systems for remote measurement of ozone and water vapor, use these systems in field programs, and, through meetings and publications, share knowledge of these systems with industry, universities, and other government agencies.
- Define concept and develop the technology to enable an ozone sensor for scientifically meaningful measurements of trace atmospheric species (i.e., ozone) from a geostationary platform.
- Implement and evaluate new methods and procedures for simulating advanced atmospheric remote sensor data, including atmospheric radiative transfer calculations and subsequent propagation through measuring instrumentation.

- Continue feasibility assessment of global tropospheric and total ozone monitoring from a space-based platform employing Fabry-Perot interferometry (FPI).
- Perform proof of concept activities for the development of an advanced tropospheric ozone remote sensor. Enhance and implement Fabry-Perot technologies into ozone spectrometer test bed and perform validation testing, including ground-based measurements of solar absorption spectra.
- Transfer 2-micron solid state laser technology to industry for infusion into New Millennium Program WINDS mission (EO-2).
- Demonstrate utility of reflected GPS signals for ionospheric total electron concentration mapping, wetlands mapping, and sea state scatterometry applications.
- Develop and transfer synthetic thinned array radiometer (STAR) technology to GSFC for soil moisture measurements.
- Complete proof of concept inflatable-membrane wave-guide for materials and performance assessment.
- Deploy a FTS on an aircraft to make proof of concept flights for sensing of cirrus clouds.
- Develop, in partnership with industry, technologies that will make possible future long-duration satellite-based lidars for measurements of clouds and aerosols.
- Continue contributions to improve the High Resolution Transmittance (HITRAN) and other atmospheric spectroscopic parameters databases.
- Advise the University of Hawaii on development of their ground-based water vapor lidar system, and validate its measurements using the LaRC LASE system.
- Develop next-generation DIAL systems for space and UAV platforms.
- Develop and enhance geophysical parameter retrieval, data analysis and assimilation, and geolocation techniques for improving and optimizing interpretation of science data from geostationary orbit.
- Develop compact, high efficiency, high energy, solid-state lidar systems for future ES atmospheric science applications.

ES Objective 3.3

Extend the use of Earth Science research to national, state, and location applications.

ES Performance Targets (FY 99)

3.3.1 Establish at least five new Regional Earth Science Applications Centers.

3.3.2 Establish 75 commercial partnerships in “value-added” remote sensing product development.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Publicize in industry, journals, through society meetings, and on the World Wide Web, the availability of surface solar energy data sets for use in solar power planning applications (FY 99).
- Update current Surface Solar Energy (SSE) web site to include further parameters of interest to the solar energy community and provide better explanations of the utility of the data (FY 99).
- Establish cooperative agreements with three business partners to evaluate the SSE database and use the data to add additional capability to their commercial products (FY 99, T3.3.2).
- Develop an advanced SSE data set at 1-degree resolution for historical parameters and quick release 1-degree resolution data set using CERES data products and algorithms.

- Study the impact of acid rain and ozone on the eastern U.S. forests and disseminate the findings.

- Develop and enhance techniques for jet stream position identification with high spatial resolution total column ozone data sets (to be obtained from geostationary platforms).

- Disseminate the results of demonstration and pathfinder projects and partnerships through a wide variety of venues and outreach activities including museums and science centers.

- Provide regional air quality monitoring to enable informed public policy decisions.

- Incorporate access to nonscience products of interest to state, local, and commercial customers into the DAAC.

- Develop space-based remote sensing mission concepts that will enable better quantification of anthropogenic aerosol direct and indirect radiative forcing so that policy makers worldwide can make informed decisions concerning control of the production of aerosols.

- Use commercially developed mission operations software and data handling systems from previous missions (SAGE, HALOE) to serve the current (SAGE III) and future program (SABER (Sounding of the Atmosphere Using Broadband Emission Radiometry)) needs in mission operations. These systems are essentially ported over and configured for the current mission at substantially less cost than would be required to develop them from scratch.

- Develop and implement mission enabling insertion of an atmospheric science payload into geostationary orbit (Geo Express Pathfinder) as a secondary payload on a commercial satellite; leverage commercial assets to reduce cost and increase Earth environmental sensing capability.

- Establish partnerships with commercial firms to offset risk and cost associated with development of new data products.

- Participate in university, industry, and government partnerships to foster the development of advanced atmospheric remote sensor technologies via Memorandum Of Agreement and similar arrangements.

- Implement DoE/Golden Field Office and NASA/LaRC Interagency Agreement to collaborate in the areas of surface radiation budget validation and commercialization of the data.

- Work with the Stennis Commercial Remote Sensing Program Office to identify and promote commercial applications of advanced concepts and technology (e.g., gas correlation radiometry technology).

- Participate with the Technology Applications Group (TAG) in the identification of nonaerospace applications of remote sensing technology (e.g., use of charge coupled device (CCD) technology for digital mammography).

- Explore the usefulness of radiative transfer and surface and cloud climatologies for architectural and illumination engineering design applications.

- Collaborate with Stennis Space Center to develop a process for continuing access to geostationary orbit via commercial satellites.

Section III

Specific Roles in Support of Space Science Enterprise

The Space Science (SS) Enterprise is pursuing four broad, near-term goals. There are eight objectives that support these goals as well as near-term activities that support the objectives. Langley has a role in supporting all eight objectives as described below. *The fiscal year of completion and the performance target number are indicated in parentheses.*

SS Enterprise Near-Term Goal 1

Chart the evolution of the universe from origins to destiny, and understand its galaxies, stars, planets, and life.

SS Objective 1.1

Solve mysteries of the universe.

SS Performance Targets (FY 99)

1.1.1 Successfully launch at least seven spacecraft within 10 percent of budget on average.

1.1.2 Complete Hubble Space Telescope three-year project and measure the Hubble constant within an accuracy of approximately 10 percent.

1.1.3 The Advanced X-ray Astrophysics Facility (AXAF) will record 100 images and spectra of galaxies at a resolution of better than an arcsecond and record data on approximately 50 compact stellar objects.

1.1.4 The Rossi X-ray Timing Explorer (RXTE) will observe physical phenomena 25,000 times closer to the event horizon of black holes than permitted with optical wavelength measurements.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- For Explorer and other flight programs, develop initial Announcement of Opportunities for OSS approval which reflect an integrated mission acquisition approach across all scientific, technical, management, cost and other program disciplines (FY 99).
- Support science peer review evaluation process as requested (FY 99).
- Manage and conduct technical, management, cost and other program factor (TMCO) evaluations (FY 99).
- Support OSS proposal selection process by presenting the TMCO results; support Office of Space Science recommendations and selection activities (FY 99).
- Support development of or develop initial NASA Research Announcements for mission data analysis and other scientific research and analysis as requested.
- Manage the Space Science Support Contract.
- Conduct space mission and systems analysis of space transportation, spacecraft, planetary entry, and sensor concepts.
- Conduct technology assessments to enhance space transportation, spacecraft, planetary entry, and sensor concepts.
- Conceive, develop, and implement computational, multidisciplinary optimization for design and development of space and trans-space transportation vehicle systems.

- Develop life-cycle analysis capability (including cost) to support independent assessments of the early conceptual stages of projects and programs for the purposes of making informed decisions on selection as well as investment choices for the SS Enterprise.

- Develop and utilize spacecraft and space transportation vehicle preliminary design and mission design and evaluation tools for application to space mission concepts.

SS Objective 1.2

Explore the solar system.

SS Performance Targets (FY 99)

1.2.1 The Near-Earth Asteroid Rendezvous (NEAR) will orbit Eros at a distance closer than 50 kilometers, measure its shape to an accuracy of 10 meters (or better), and complete the first direct compositional measurement of an asteroid.

1.2.2 The Lunar Prospector will map the 75 to 80 percent of the Moon's surface not accessible during the Apollo missions and provide definitive measurements of the weak lunar magnetic field.

1.2.3 The Transition Region and Coronal Explorer (TRACE) will observe energy propagation from solar disturbances beginning at the bottom of the visible solar atmosphere into the corona high above with a spatial resolution five times better than previous capabilities.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Develop Announcement of Opportunity for the Discovery Program and other flight programs (FY 99).

- Manage the proposal evaluation process (FY 99).

- Conduct technical, management, cost, and other program factor evaluations (FY 99).

- Manage the proposal selection process and support Office of Space Science recommendation and selection activities (FY 99).

- Develop NASA Research Announcements for mission data analysis and other scientific research and analysis.

- Conduct space mission and systems analysis of space transportation, spacecraft, planetary entry, and sensor concepts.

- Conduct technology assessments to enhance space transportation, spacecraft, planetary entry, and sensor concepts.

- Conceive, develop, and implement computational, multidisciplinary optimization for design and development of space and trans-space transportation vehicle systems.

- Develop life-cycle analysis capability (including cost) to support independent assessments of the early conceptual stages of projects and programs for the purposes of making informed decisions on selection as well as investment choices for the SS Enterprise.

- Develop and utilize spacecraft and space transportation vehicle preliminary design and mission design and evaluation tools for application to space mission concepts.

SS Objective 1.3

Discover planets around other stars.

SS Performance Target (FY 99)

1.3.1 Assemble and laboratory test the interferometer beam combiner connecting the twin 10-meter telescopes at the Keck Observatory in Hawaii.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Develop Announcement of Opportunity for the Discovery Program and other flight programs (FY 99).
- Develop NASA Research Announcements for mission data analysis and other scientific research and analysis.
- Manage the proposal evaluation process (FY 99).
- Conduct technical, management, cost, and other program factor evaluations (FY 99).
- Manage the proposal selection process and support Office of Space Science recommendation and selection activities (FY 99).

SS Objective 1.4

Search for life beyond Earth.

SS Performance Targets (FY 99)

1.4.1 The Galileo spacecraft will complete 11 encounters with Jupiter's moon Europa and conduct investigations that will help determine the presence and state of water, a central consideration in understanding the possibility of life on this moon.

1.4.2 Initiate the Astrobiology Institute's operations by linking up to eight institutions and engaging approximately 50 investigators to promote publication of interdisciplinary research and foster effective public education and outreach about research on life in the universe.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Develop NASA Research Announcements for mission data analysis and other scientific research and analysis.
- Manage the proposal evaluation process.
- Conduct technical, management, cost, and other program factor evaluations.
- Manage the proposal selection process and support Office of Space Science recommendation and selection activities.

SS Enterprise Near-Term Goal 2

Use robotic missions as forerunners to human exploration beyond low-Earth orbit.

SS Objective 2.1

Investigate the composition, evolution, and resources of Mars, the Moon, and small bodies.

SS Performance Target (FY 99)

2.1.1 The Mars Global Surveyor (MGS) will achieve the final science orbit, measure the topography with 10-meter precision, provide high-resolution 1.5 meter imaging data, and provide the first thermal infrared spectrometry of the planet.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Support aerobraking of Mars Global Surveyor spacecraft (FY 99).
- Support design of Stardust entry vehicle (FY 99).
- Determine aeroshell configuration and support design of Mars Microprobes (New Millennium DS-2 mission).
- Support Mars Surveyor 1998 mission design (aerobraking and direct entry).
- Support Mars Surveyor 2001 lander design.
- Develop candidate guidance concepts and aerodynamic database for Mars Surveyor 2001 missions.
- Lead atmospheric flight team in support of Mars Surveyor 2001 mission design.

- Develop guidance system test bed to simulate and evaluate a range of atmospheric guidance options applicable to the 2001 aerocapture and precision landing goals (FY 99).
- Support aeroassist technology development for the Mars Surveyor 2003 and 2005 missions.
- Explore Mars ascent vehicle design space and trades for sample-return mission.
- Evaluate and develop innovative sample-return capsule designs.
- Develop and integrate analysis models for ARC, JPL, and LaRC Integrated Design System for planetary entry vehicles.
- Develop and implement planetary entry analysis tools for robotic and human space flight missions including operational, development, and conceptual systems for Earth orbit and planetary systems.
- Conduct space mission and systems analysis of space transportation, spacecraft, planetary entry, and sensor concepts.
- Conduct technology assessments to enhance space transportation, spacecraft, planetary entry, and sensor concepts.
- Conceive, develop, and implement computational, multidisciplinary optimization for design and development of space and trans-space transportation vehicle systems.
- Develop life-cycle analysis capability (including cost) to support independent assessments of the early conceptual stages of projects and programs for the purposes of making informed decisions on selection as well as investment choices for the Space Science Enterprise.
- Develop and utilize spacecraft and space transportation vehicle preliminary design and mission design and evaluation tools for application to space mission concepts.
- Develop Announcements of Opportunity for the Mars Program, Discovery Program, and other flight programs (FY 99).
- Develop NASA Research Announcements for mission data analysis and other scientific research and analysis.
- Manage the proposal evaluation process (FY 99).
- Conduct technical, management, cost, and other program factor evaluations (FY 99).
- Manage the proposal selection process and support Office of Space Science recommendation and selection activities (FY 99).

SS Objective 2.2

Improve the reliability of space weather forecasting.

SS Performance Targets (FY 99)

2.2.1 Conduct solar activity observations with a series of NASA spacecraft to achieve complete coverage (maximum and minimum) of the solar cycle, an increase from 35 percent.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Develop and operate the Sounding of the Atmosphere Using Broadband Emission Radiometry (SABER) instrument on the Thermosphere, Ionosphere, Mesosphere Energy and Dynamics (TIMED) Mission. Conduct scientific investigations that substantially contribute to our knowledge of the energetics, chemistry, dynamics, and transport of the mesosphere and lower thermosphere and ionosphere and the relationship to solar activity.
- Provide management and scientific oversight of SABER flight instrument development, leading to a launch on schedule (May 2000).

- Lead the SABER science team in the development of algorithms for the retrieval of atmospheric data from the flight instrument data.
- Provide management and scientific oversight of SABER mission operations and data analysis software.
- Provide management and scientific oversight of SABER instrument operations (2000-2002).
- Conduct scientific investigations of the energetics, chemistry, dynamics, and transport of the mesosphere and lower thermosphere in collaboration with the SABER and TIMED science teams.
- Conduct space mission and systems analysis of space transportation, spacecraft, planetary entry, and sensor concepts.
- Conduct technology assessments to enhance space transportation, spacecraft, planetary entry, and sensor concepts.
- Conceive, develop, and implement computational, multidisciplinary optimization for design and development of space and transspace transportation vehicle systems.
- Develop life-cycle analysis capability (including cost) to support independent assessments of the early conceptual stages of projects and programs to make informed decisions on selection as well as investment choices for the SS Enterprise.
- Develop and utilize spacecraft and space transportation vehicle preliminary design and mission design and evaluation tools for application to space mission concepts.
- Develop Announcements of Opportunity for the Solar-Terrestrial Probes Program and other flight programs (FY 99).
- Develop NASA Research Announcements for mission data analysis and other scientific research and analysis.
- Manage the proposal evaluation process (FY 99).
- Conduct technical, management, cost, and other program factor evaluations (FY 99).
- Manage the proposal selection process and support Office of Space Science recommendation and selection activities (FY 99).

SS Enterprise Near-Term Goal 3

Develop new critical technologies to enable innovative and less costly mission and research concepts.

SS Objective 3.1

Develop innovative technologies for Enterprise missions and for external customers.

SS Performance Targets (FY 99)

3.1.1 The New Millennium Program (NMP) will demonstrate an electricion propulsion system with specific impulse ten times greater than chemical propulsion systems.

3.1.2 The Micro-Arcsecond Metrology Test bed will demonstrate an improvement in positioning accuracy to the picometer (millionth-millionths of a meter) range, ten times better than previously achieved.

3.1.3 The Mars 98 Lander will demonstrate an advanced robotic manipulator with improved performance of an order of magnitude compared to the manipulator used on Viking in 1976.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Demonstrate conductive cooling for laser diodes using carbon-carbon composites.

- Demonstrate high precision piezoelectric actuators capable of operation at cryogenic temperatures.
- Demonstrate pathfinder rapid modeling and analytical simulations for combined mechanical and thermal loads.
- Demonstrate multidisciplinary prototype analysis and design system utilizing computational intelligent simulations with structures, dynamics, thermal management, manufacturing costs, and risk/uncertainty management.
- Complete precision deployable reflector test article.
- Develop avionics technology for engineering data system on a chip and rad hard microcontrollers.
- Develop and characterize thin-film materials for inflatable structures, NGST sunshield, and solar sails.
- Develop analytical tools for modeling nonlinear structural mechanics and wrinkling of inflatable membranes.
- Develop concepts for lightweight high payload volume, protective sample-return, aeroshell spacecraft.
- Develop and test concepts for collapsible structures to absorb landing impact.
- Flight validate conformal radiation shielding material for microelectronics.
- Develop and test proof-of-concept chip on structure panel.
- Develop and test neutron radiation shielding material.
- Conduct NASA Research Announcement to solicit innovative microlidar technology for Earth and planetary sciences.

SS Enterprise Near-Term Goal 4

Contribute measurably to achieving the science, math, and technology education goals of our nation, and share widely the excitement and inspiration of our missions and discoveries.

SS Objective 4.1

Incorporate education and enhanced public understanding of science as integral components of Space Science missions and research.

SS Performance Targets (FY 99)

4.1.1 Account for 4 percent of the 150 “most important science stories” in the annual review by *Science News.*

4.1.2 Account for no less than 25 percent of total contributions to the college textbook Astronomy: *From the Earth to the Universe.*

4.1.3 Each new SS Enterprise mission initiated in FY 99 will have a funded education and outreach program.

4.1.4 The SS Enterprise will complete an organized network of contacts by the end of FY 99 to work with educators and space scientists to formulate and implement space science education and outreach programs.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Evaluate how well proposals submitted to the Office of Space Science in response to Announcements of Opportunity meet the stated goals (FY 99, T4.1.3).
- Support the Office of Space Science recommendation and selection processes as they relate to the education and public outreach goals (FY 99, T4.1.3).

Section IV

Specific Roles in Support of Human Exploration and Development of Space Enterprise

The NASA 1998 Strategic Plan provides direction for the Agency's long range plans for sustaining human presence in space. The Langley Research Center serves a fundamental role in supporting the Human Exploration and Development of Space (HEDS) Enterprise goals, objectives, and strategies as identified in the time-phased Human Exploration and Development of Space Road Map in the Strategic Plan through the Center's innovative research activities and state-of-the-art systems analysis. *The fiscal year of completion and the performance target number are indicated in parentheses.*

HEDS Enterprise Near-Term Goal 1

Explore the role of gravity in physical, chemical, and biological processes.

HEDS Objective 1.1

Enable the research community to use gravity as an experimental variable.

HEDS Performance Targets (FY 99)

1.1.1 Publish at least 90 percent HEDS sponsored research data and make it accessible on the Internet.

1.1.2 Expand the number of sponsored investigations to 795.

1.1.3 Establish an integrated NASA-wide program in evolutionary biology led by the National Center for Evolutionary Biology.

1.1.4 Demonstrate and utilize for the first time state-of-the-art techniques on Neurolab to understand the function of the nervous system.

1.1.5 Compare responses of at least three different biological models to understand the influence of gravity on the nervous system.

1.1.6 Define the time course of adaptions in the balance systems to altered gravitational environments.

1.1.7 Analyze data from Mir to achieve

1.1.7.1 A one-crew-year start for ISS biomedical and countermeasures research.

1.1.7.2 A one-crew-year start for International Space Station (ISS) fundamental biology and regenerative life support research.

1.1.7.3 A three-crew-year start for cell culture and protein crystal growth research.

1.1.8 Analyze radiation research data from Mir and incorporate findings into planning for EVA activities on ISS to minimize crew exposure.

1.1.9 Improve our predictive capabilities of soot processes by at least 50 percent through the analysis of MSL-1 data.

1.1.10 Use the MSL-1 results to eliminate one of three primary fluid flow regimes from consideration by casting engineers.

1.1.11 Use data obtained by fluid physics experiments on suspensions of colloidal particles on MSL-1 to answer fundamental questions in condensed matter physics.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Support investigation of the anomaly that occurred on the Electronic Materials Crystal Growth Experiment on USMP-3. Complete analysis and evaluation of experiment flight crystals and report results (T1.1.1).

HEDS Enterprise Near-Term Goal 2

Continue to open and develop the space frontier.

- Develop and assemble the ISS and utilize it to advance scientific exploration, engineering, and commercial activities.
- Provide safe and affordable human access to space.

HEDS Objective 2.1

Improve Space Shuttle program operations by safely flying the manifest and aggressively pursuing a systems upgrade program.

HEDS Performance Targets (FY 99)

2.1.1 Achieve seven or fewer flight anomalies per mission.

2.1.2 Achieve 85 percent on-time, successful launches.

2.1.3 Achieve a 13-month flight manifest preparation time.

2.1.4 Achieve a 60 percent increase in predicted reliability of the Space Shuttle.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Integrate and conduct the flight of the Fiber Optic Sensor System (FOSS) as part of the Space Shuttle Integrated Vehicle Health Maintenance (IVHM) program.
- Continue to support Phase IV Space Shuttle Upgrades including aerothermodynamic characterization of Liquid Fly-Back Booster (LFBB) configurations.
- Continue to support Space Shuttle Super Lightweight Tank component testing.

HEDS Objective 2.2

Deploy and operate the ISS for research, engineering, and exploration activities.

HEDS Performance Targets (FY 99)

2.2.1 Deploy the Service Module, and the U.S. Laboratory Module, establish a three-person human presence, and establish initial ISS research capability.

2.2.2 Complete integration for the first EXPRESS rack with five payloads ready for launch at the beginning of fiscal year 2000.

2.2.3 Complete preparations for the launch of the first rack of the Human Research Facility and the Window Observational Research Facility on the first utilization flight.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Identify and assess candidate improvements in analysis capabilities which reduce costs, improve margins, improve safety, or increase performance of the current ISS design.
- Create and exploit an analysis environment that facilitates the evaluation of potential ISS commercialization opportunities.
- Develop and assess engineering requirements necessary to complete a distributed intercenter synthetic Space Station environment.
- Provide systems analysis engineering support to the Headquarters Advanced Projects Office to

- ❍ Define and prioritize Office of Space Flight technology requirements and advanced development and flight demonstration projects to be flown aboard ISS to meet current and future HEDS requirements.
- ❍ Identify and assess candidate improvements to the current ISS design.
- ❍ Assess and develop an ISS evolution plan to meet long-term HEDS requirements as part of the ISS Pre-Planned Program Improvement activity.

- Provide systems analysis engineering support to the ISS Program Office Chief Engineer to support risk mitigation and critical nonbaseline assessments.

HEDS Objective 2.3

Ensure the health, safety, and performance of space flight crews.

HEDS Performance Target (FY 99)

2.3.1 Complete the development of countermeasure research protocols, and begin testing a minimum of three countermeasures intended to protect bone, muscle, and physical work capacity.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Analyze radiation research data form Mir and incorporate findings into planning for extra vehicular activity (EVA) activities on ISS to minimize crew exposure (T2.3.1).

HEDS Enterprise Near-Term Goal 3

Prepare to conduct human missions of exploration.

HEDS Objective 3.1

In partnership with the SS Enterprise, carry out an integrated program of robotic exploration of the solar system to characterize the potential for human exploration and development.

HEDS Performance Targets (FY 99)

3.1.1 Initiate a collaborative program to design and develop radiation and soil/dust measuring devices.

3.1.2 Plan for demonstration of in situ propellant production.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Establish precision landing capability.
  - ❍ Support the entry and precision landing analysis, design, and operations for the Mars 1998, 2001, 2003, and 2005 mission opportunities.
- Support the aeroshell design and selection for the 2001, 2003, and 2005 Mars mission opportunities.
- Support the characterization of space transit and surface radiation environments to which missions will be exposed to protect humans and shield microelectronic devices.
- Define and advocate a Martian Exposure Facility (MEF) for the 2003 Mars mission to characterize the effects of the Martian environment on materials necessary to enable the human exploration of Mars.
- Conduct independent assessments of future Mars robotic missions to ensure design suitability, cost realism, schedule realism, and technical feasibility.
- Continue the analysis and design of Mars sample return entry systems in support of the 2005 Mars mission.
- Continue the development of microcontrollers and flexible, lightweight power system components to support reduced mass, volume, and power requirements (T3.1.2).

HEDS Objective 3.2

Explore and invest in enabling crosscutting technology and studies that can affordably open the frontiers for human space exploration where there is a compelling rationale for human involvement.

HEDS Performance Targets (FY 99)

3.2.1 Evaluate options and define exploration technology investment plan.

3.2.2 Demonstrate advanced technologies, including a biological water processor and a new electronic sensor on a chip capable of realtime continuous toxicological measurements.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Continue to support the development of a technology plan which enables viable and efficient human space exploration beyond low Earth orbit.
- Continue to identify, define, and advocate near term tests and demonstrations that advance the state of the art in key structures, materials, and radiation protection technologies necessary to enable efficient human space exploration beyond low Earth orbit.
- Support transportation architecture studies to define innovative concepts for human exploration including the Solar Electric Transfer Vehicle (SETV) study.
- As the Center of Excellence for Structures and Materials, support HEDS mission architecture and technology development with emphasis on advanced composites, inflatable structures, and radiation protection materials.
- Continue to support aerobrake utilization studies, including the Mars TransHab Aeroshell, to assess mission architecture implications and identify technology investment requirements.
- Conduct assessments to identify systems and technologies to meet HEDS mission precision landing and vehicle guidance, navigation, and control requirements.
- Conduct research and flight experiments on advanced protective shield materials to reduce the risk to humans from space radiation.
- Develop integrated vehicle and radiation protection concepts to reduce the risk to humans from space radiation during long-duration transit and surface stay time.

HEDS Enterprise Near-Term Goal 4

Aggressively seek investment from the private sector.

- Increase the affordability of space operations through privatization and commercialization.
- Share HEDS knowledge, technologies, and assets that promise to enhance the quality of life on Earth.

HEDS Objective 4.1

Promote investments in commercial assets as pathfinders in ISS commercial operations and reduce the cost of Space Shuttle operations through privatization, eventual commercialization, and flying payloads.

HEDS Performance Targets (FY 99)

4.1.1 Complete development of a commercialization plan for the ISS and Space Shuttle in partnership with the research and commercial investment communities.

4.1.2 Attract $250M in private capital to establish an improved logistics and research capability for the Space Shuttle.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Conduct a Phase A study to define the interface between current commercial RLV concepts and government-provided human and unmanned cargo carriers.

HEDS Objective 4.2

Reduce space communications and operations costs through privatization and eventual commercialization.

HEDS Performance Targets (FY 99)

4.2.1 Reduce space communications operations costs by 30 to 35 percent through a consolidated space communications contract.

4.2.2 Develop options and recommendations to commercialize space communications through a Federal Government corporation.

HEDS Objective 4.3

Foster consortia of industry, academia, and government. Leverage funding, resources, and expertise to identify and develop commercial space opportunities.

HEDS Performance Targets (FY 99)

4.3.1 Increase industry investment in space research to $50M in FY 99.

4.3.2 Establish two new Commercial Space Centers: one for food technology and one for environmental systems.

HEDS Objective 4.4

Involve our Nation's citizens in the adventure of exploring space and transfer knowledge and technologies to enhance the quality of life on Earth.

HEDS Performance Targets (FY 99)

4.4.1 Initiate a curriculum development program in partnership with ITEA for gravity-related educational modules.

4.4.2 Expand the microgravity research program World Wide Web-based digital image archive established in 1998 by 50 percent.

4.4.3 Conduct two Telemedicine Instrumentation Pack demonstrations.

4.4.4 Demonstrate the application of laser light scattering technology for early detection of eye-tissue damage from diabetes.

LaRC Commitments Including Contributions to Enterprise Performance Targets

- Collaborate with the LaRC Office of Education in production, development, dissemination, and evaluation of education outreach programs.
- Provide direct interaction between NASA personnel and students through outreach activities including National Engineers Week volunteers, National Science Olympiad sponsorship, state fair demonstration, and public broadcast educational programs.
- Use the Internet to provide direct involvement of the public and educational communities for participation in exploration definition and achievement.
- Enhance the curriculum of educators with information and materials generated by the HEDS Enterprise programs, technologies, and discoveries.
- Provide facilities and resources at LaRC for universities offering advanced degrees in aerospace engineering and management.
- Showcase LaRC research and technology activities to the commercial sector through a biannual open house.

Section V

Core Competencies

Core competencies are the distinguishing integration of skills, facilities, and technological capabilities that provide Langley with the unique capacity to perform its mission and programs. These core competencies differentiate Langley from other organizations, are essential to accomplishing the Center mission, and are extendible to new applications in both aerospace and nonaerospace industries The figure below depicts Langley's core competencies at the highest level. The core competency elements are used to implement the research programs listed in Sections I-IV.

In addition to the technical competencies listed below, LaRC possesses the Technology Program Management core competency that includes the ability to conceive and manage complex Technology Development Programs. This competency is manifested by leadership of numerous Technology Development Programs of extreme importance to the Agency and the Nation. This competency requires the ability to create national alliances to leverage technologies and to carry concepts to application.

Mission and Systems Analysis, Integration, and Assessment

Aeronautics

- Identify and prioritize new aeronautical concepts and systems, including the critical technologies involved, investment options, and system-level global and societal benefits resulting from proposed programs for subsonic through hypersonic speed vehicles.

- Provide continuing evaluations and technology assessments for ongoing focused and base programs.

- Develop advanced methods and data for performance, economic, and safety assessments of aeronautical systems, including vehicles and the integrated air transportation system.

- Conceive, develop, and validate multidisciplinary methods for analysis and design of aerospace systems and products.

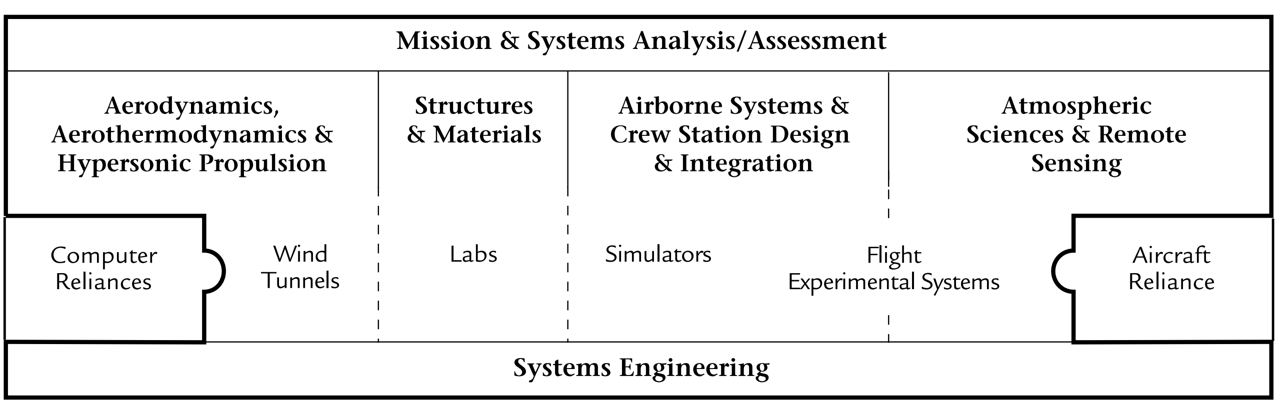

Figure 2. Langley core competencies.

Space

- Conduct mission and systems analysis of advanced space transportation, spacecraft, planetary entry, and sensor concepts.
- Lead independent assessments of critical space missions for the Agency.
- Conduct technology assessments to evaluate space transportation, spacecraft, planetary entry, and sensor concepts.
- Conceive, develop, and implement computational, multidisciplinary optimization for design and development of space and trans-space transportation vehicle systems.
- Develop life-cycle analyses (including cost) to support independent assessments of the early conceptual stages of projects and programs for the purpose of making informed decisions on selection as well as investment choices for the Agency.
- Develop and utilize analysis tools for spacecraft and space transportation vehicle preliminary design and mission design for application to flight mission concepts, Agency space mission concepts, and independent assessment evaluations.
- Develop and apply planetary entry analysis tools to robotic and human space flight missions for Earth orbit and planetary systems.

Aerodynamics, Aerothermodynamics, and Hypersonic Air-Breathing Propulsion

- Develop, assess, and apply aerodynamic and component integration technologies to enable development of advanced subsonic, supersonic, and high performance aircraft.
- Manage, operate, and provide aerodynamic, aerothermodynamic, aero- and hypersonic-propulsion, and acoustic test capabilities for Agency and industry research and development of a broad class of aerospace vehicles.
- Develop, assess, and apply aerothermodynamic technologies to enable development of hypersonic aircraft, launch vehicles, and planetary and earth entry systems.
- Develop, assess, and apply hypersonic air-breathing propulsion technologies to enable development of hypersonic air-breathing vehicles.
- Develop, assess, and apply acoustic technologies in the development of advanced aerospace systems and to meet environmental requirements.

Structures and Materials

- Develop advanced materials and processing technologies to enable the fabrication of low-cost structural concepts for high performance aerospace applications.
- Conduct research and technology development that accurately and efficiently predicts behavior, durability and damage tolerance, evaluates concepts, and validates performance of advanced materials for aerospace structures.
- Conduct research and technology development for advanced sensors, intelligent systems, and ground operational behavior to ensure structural integrity, reliability, and safety for aerospace vehicles.
- Conduct research and technology development to quantify and control aeroelastic response, unsteady aerodynamic flow phenomena, and structural dynamics behavior for flexible aerospace vehicles.
- Develop precision deployable and inflatable structures technology for large apertures, and advanced actuators for control of aperture geometry and structural dynamics.

Airborne Systems and Crew Station Design and Integration

- Design, build, integrate, and test highly reliable, digital electronic and electromagnetic systems for aerospace applications.
- Develop and demonstrate methodologies for designing and verifying high integrity digital and electromagnetic systems in mission or life critical aerospace applications.
- Develop techniques to use microgravity environment to improve semiconductor materials.
- Develop aerospace vehicle flight dynamics design requirements, modeling methods, analysis tools, and test techniques and conduct flight dynamics evaluations of aerospace vehicle configurations.
- Develop and validate guidance and control design methods, analysis tools, and algorithms for aerospace vehicles.
- Develop requirements, concepts, and design guidelines for flight deck systems and their integration into airplane flight decks.

Atmospheric Sciences and Remote Sensing

- Conceive, develop, and use advanced instrumentation to observe, characterize, and analyze regional and global atmospheric processes with emphasis on remote sensing from space.
- Develop advanced technologies and measurement techniques to enable new science measurements and to reduce science instrument life cycle cost.
- Develop and utilize theoretical models and analytical techniques to interpret atmospheric observations and understand global change.
- Produce, analyze, interpret, and disseminate atmospheric data sets necessary for understanding atmospheric radiative, chemical, dynamical, and meteorological processes and interpreting trends.
- Identify critical atmospheric science issues and contribute to national and international assessments of the environment, including the impact of aircraft and other anthropogenic activities on long term global changes.
- Conduct analysis, design, and hardware development of advanced materials and structures, detectors, electro-optic materials, and controls for advanced aircraft and spacecraft remote sensing systems.
- Develop advanced remote sensing technique instrumentation and integrated sensors for low cost, high performance monitoring of Earth and planetary atmospheres.
- Develop models and perform measurements and simulation for advanced electro-optic materials and atmospheric lidar systems to predict system performance in both Earth and planetary atmospheres.
- Develop advanced diode-pumped solid-state lasers and lidar systems to meet the unique atmospheric science needs of the Earth Science and Space Science Enterprises.
- Leverage Space and Atmospheric Science remote sensing technology to develop atmospheric monitoring instruments applicable to aircraft operations performance and safety.

Systems Engineering

The Systems Engineering Core Competency is very broad in order to provide support for the wide range of research core competencies. It is a strategic combination of skills, technologies, and acquired knowledge that provide Langley with a competitive edge in performing its mission and programs. The process for systems engineering includes deriving requirements from program/project goals, creating design concepts, performing design studies, selecting/implementing design, verifying design, assessing design, and integrating/ maintaining systems.

- **Aeronautical and Space Research Facility Systems**—Provide technical and developmental engineering support for electrical, mechanical, instrumentation, and data systems to design, construct, activate, and maintain aerospace research facilities, equipment, and associated institutional facilities for aeronautical and space research.
- **Experimental Testing Technology**—Provide the concept, design, development, application, and integration of models, model and facility instrumentation, data acquisition, measurement, and end-to-end test systems for aeronautics and space research.
- **Fabrication Technology Development**—Provide advanced product and process development for fabrication technologies in metals, electronics, and composites applications in support of the Center's engineering and research organizations during the design, fabrication, and testing of research models and instruments, flight and related ground support hardware, facility components, and laboratory test apparatus.
- **Software Enginering**—Provide engineering support for the development and application of unique software systems for data, control, and information technology applications to improve the productivity and quality of the products and services necessary to carry out the Center's aerospace research and support missions.
- **Flight Aerospace Systems Development**—Provide systems engineering services, including bid and proposal preparation, enabling technology development and independent assessment, for the development of flight aerospace research and technology programs.

Section VI

Agency Support Activities

A broad range of personnel, facility, and operational support services is required to support NASA's ambitious mission. Just as NASA is streamlining its technical activities by establishing Centers of Excellence for technical development, so too is it consolidating many of its Agencywide support activities at specific Centers to reduce duplication of effort, enhance performance, and bring overall operational costs down. NASA Headquarters has assigned the following Agency support activities to the Langley Research Center.

Lead for Non-Destructive Evaluation

Goal

- Deliver significant improvements in safety, reliability, and probabilities for mission success.

Objectives

- Develop and maintain Agencywide NDE infrastructure, relevant cost-effective NDE methodology, and instruments and transfer them to other Centers and industry.
- Strengthen cooperative NDE efforts among the Centers and Programs.
- Identify potential safety and reliability areas of concern.

LaRC Implementation Strategy

- The NDE Program will closely coordinate, via the NASA NDE Working Group (NNWG), with all interested Headquarters Offices and Centers.
- Develop and maintain a coordinated and comprehensive Agencywide NDE program.
- The NDE task execution within the NDE Program will be the responsibility of representatives at the Centers.

Lead for Scientific and Technical Information

Goal

- Foster innovative ways for NASA to collect, organize, publish, archive, and disseminate not only the Scientific and Technical Information (STI) that it produces but also the relevant and timely information that it obtains from the scientific and technical community outside the Agency.

Objectives

- Establish and maintain a strategy for acquisition, preservation, and dissemination of STI products and services which is responsive to NASA mission objectives.
- Base the program on identified customer and stakeholder needs by designing and evaluating our products and services based on these needs, how the information is used, and what will be needed in the future.
- Acquire and maintain a comprehensive, relevant repository of STI.
- Capture, preserve, and disseminate 100 percent of NASA-produced STI and reduce the time required to locate, capture, and disseminate this STI.
- Ensure an equitable balance of STI exchange between NASA and NASA's exchange partners, particularly the foreign data exchange partners.

- Provide seamless electronic full-text delivery (using navigators and organizers) to the desktop by using advanced computer systems for a wide variety of information types, formats, and media that are essential to and advance the knowledge and competitiveness of our customers.

- Radically reduce the number of divergent systems and databases that our customers must use to access information.

- Link the STI Program to other world-class information programs and foster collaborative internal and external partnerships.

- Streamline information resources and processes to remove duplication and redundancies.

- Implement mechanisms for performance measurement, feedback, and continuous improvement.

- Maintain access to STI personnel who can provide training, act as problem solvers, or provide assistance when customers need more help than can be provided via their desktops.

- Make STI products and services known and educate customers in their most effective use.

LaRC Implementation Strategy

- Establish infrastructure to implement lead Center activity for the STI Program.

- Initiate a Business Process Re-engineering (BPR) Assessment of Agency STI Program and recommend changes to Headquarters and implement approved changes.

- Revise and get approval for STI Program procedures and guidelines.

- Reduce the costs of operation of, improve the efficiency for, and integrate the goals of the Center for AeroSpace Information (CASI) with the strategic goals of the STI Program.

Lead for Program/Project Management Initiative Training

Goal

- Provide education and development support to intact project management teams.

Objectives

- Establish a protocol of services and products that can be available to all NASA project teams.

- Work with pilot project teams to provide educational and team support to enhance the effectiveness of project performance.

- Establish metrics to identify the value of intact team efforts.

LaRC Implementation Strategy

- Provide training and tools to intact project management teams.

- Benchmark with other organizations to learn how they assess the effectiveness of team efforts.

- Improve and assess the effectiveness of project management teams through team training and development.

Section VII

Functional and Staff Areas

To assure that the Langley Research Center is successful in accomplishing its mission, an effective and efficient structure must be in place to carry out essential support activities. The goals, objectives, and implementation strategies for the various support functions are delineated in this section.

Chief Counsel

Goal

- Provide high quality legal advice and assistance; innovative, effective, and professional representation and counsel; and make valued contributions as essential members of the LaRC and NASA teams.

Objectives

- Increase the efficiency, accuracy, and timeliness of legal services.
- Maintain and enhance the professionalism of the OCC (Office of Chief Counsel) staff.
- Maintain and further develop excellent internal and external relationships with clients, customers, and stakeholders by providing thoroughly researched legal advice.
- Practice preventative law to the maximum extent feasible.
- Assist in fulfilling the NASA and LaRC value of integrity.

LaRC Implementation Strategy

- Maintain and enhance an ethics program that will promote the observance of high ethical standards and integrity.
- Maintain an OCC World Wide Web page as an effective communication tool to address legal and ethics issues in a meaningful yet friendly manner.
- Develop new and innovative legal instruments and relationships to facilitate partnering and technology transfer efforts.
- Support programmatic efforts through legal assistance and meaningful reviews of contractual instruments.
- Actively support the implementation of processes to manage technical and proprietary data.
- Anticipate legal issues through proactive contacts with Center clients.
- Develop a solid understanding of the Center's major programs by visiting clients, touring their facilities, and by inviting them to OCC as guest speakers.
- Present a positive, enthusiastic image to Center clients and external customers.
- Render pro-active legal advice by offering options, using innovative approaches, providing risk analyses, and encouraging risk-taking where appropriate.
- Prepare and distribute checklists for legal review of common actions so clients will be aware of legal issues.
- Prepare OCC internal procedures documentation.
- Encourage and facilitate dispute avoidance practices.
- Represent our client before adjudicatory forums and where appropriate successfully resolve disputes with Alternative Disputes Resolution, including settlement.

- Monitor client relations by developing a client feedback questionnaire to help ensure that client expectations for legal support are met or exceeded.

Education Outreach Programs

Goal

- Communicate widely within the formal and informal educational communities the content, relevancy, and excitement of NASA missions and discoveries to inspire America's students and promote excellence in education, to create learning opportunities, and to increase understanding and the broad application of science, mathematics, and technology.

Objectives

- Develop and implement science, mathematics, engineering, and technology education programs, services, and research opportunities, consistent with the Goals 2000 Standards, that meet the needs of educators and students at all levels within the formal and informal educational institutions and effectively communicate NASA's mission to these communities.
- Using computer and information technology communicate the services and products of the Agency and Center to all customers in the educational community; inspire students, parents, teachers, faculty, and the public with NASA's missions and accomplishments; and leverage resources to reach the most appropriate audience with the best available information.

LaRC Implementation Strategy

- Support America's in-service and preservice teachers, faculty, and students through the use of facilities and resources to enhance knowledge and skills in science, mathematics, engineering, and technology.
- Facilitate development of instructional products based on NASA's unique mission and provide access to these products through the innovative use of technology.
- Focus teacher, faculty, parent, and student programs and products on the Strategic Enterprises and Langley Research Center Roles and Missions.
- Align all educational products with the national standards for science, mathematics, geography, and technology education.
- Use professional educators to develop and document program outcomes.
- Coordinate programs and products with state framework efforts and systemic change in science, mathematics, and technology education.
- Use a variety of information technologies, telecommunications, and distance learning techniques to communicate the results of NASA sponsored research and promote educational excellence.
- Evaluate processes, services, and programs annually and implement Education Computer Aided Tracking System (EDCATS).
- Develop external resource partnerships and alliances with local, state, regional, and national associations; school systems; and schools.
- Develop internal partnerships to support educational and public outreach efforts.

Equal Opportunity

Goal

- Create a work environment that is free of unlawful discrimination and sexual harassment, accessible to individuals with disabilities, ensures fair and equitable treatment for all employees, values workforce diversity, and fosters mutual respect in an effort to achieve the mission of the Agency and Langley.

Objectives

- Ensure that all policies, procedures, and processes provide all employees an equal opportunity to develop, participate, and compete fairly and equitably.
- Ensure that workforce representation in all occupations and at all levels is reflective of the nation's diversity.
- Ensure that all facilities are accessible and reasonable accommodations are provided to disabled employees.

LaRC Implementation Strategy

- Conduct review of all policies, procedures, and processes to ensure that equal opportunity is afforded all employees.
- Provide all employees, including managers and supervisors, a copy of Langley's Affirmative Employment Plan.
- Monitor recruitment, hiring, and advancement, where opportunities exist, to ensure the inclusion of minorities, females, and the disabled.
- Coordinate EEO (Equal Employment Opportunity) training for all employees, including managers and supervisors, to ensure awareness of laws and regulations governing unlawful workplace discrimination, affirmative employment, and accessibility for the disabled.
- Provide all employees available information on avenues of redress for workplace disputes and allegations of unlawful discrimination.
- Select and train EEO counselors reflective of the workforce by occupation, race, gender, and culture.
- Foster mutual respect through special emphasis program observances and committees, such as Federal Women's Program Committee, Satellite Committee for Persons with Disabilities, and Multicultural Leadership Team.

External Affairs

Goal

- Expand knowledge of and foster recognition and support for Langley Research Center, its employees, and its programs by ensuring that the value of LaRC is understood by its stakeholders: the public, strategic partners, and National decision makers.

Objective

- Inform stakeholders how LaRC improves American technological and economic competitiveness in the global marketplace, ensures National security, and improves the quality of life.

LaRC Implementation Strategy

- Coordinate the funding and implementation of the LaRC Stakeholder Value Communication Strategy, which calls for the use of all available communications tools and strategies to promote extensive communications with stakeholders.
- Update the LaRC Stakeholder Value Communication Strategy, develop annual goals and advocate for funding and support to implement this strategy and these goals with stakeholder value projects.
- Promote the Stakeholder Value Communication Strategy to all LaRC organizations, managers, and employees.

Financial Management

Goal

- Effectively and efficiently facilitate the accomplishment of the Center's mission through innovative and flexible resources management and financial accounting in accordance with applicable laws, regulations, and policies.

Objective

- Develop and implement budget and accounting policies, procedures, systems, and controls. In addition, the office provides Center management with advice and information on utilization of financial resources.

LaRC Implementation Strategy

- Support the development and implementation of the Agency's Integrated Financial Management Program (IFMP).
- Support the development and implementation of the Agency's full cost management, budget, and accounting systems.
- Prepare audited Center and Agency financial statements.

Human Resources

Goal

- Ensure that LaRC has a productive, skilled, and diverse workforce to accomplish the Center's missions, programs, and projects.

Objectives

- Develop tactical plan to ensure that LaRC will be a model of human resource (HR) strategic leadership and proactive in achieving goals and objectives.
- Develop processes that are efficient and effective and lead to high quality, innovative, creative products and services.
- Increase automation for managerial processes and increase availability of desktop HR data to managers.
- Develop an HR team, upgrading staff’s productivity and cross-functional skills.
- Maintain internal and external HR partnerships characterized by mutual support and cooperation to deliver quality and timely products and services.

LaRC Implementation Strategy

- Improve HR process by implementing new promotion and award process and procedures providing more flexibility delegated to managers and linked to fiscal resources.
- Provide excellent personnel systems and services which enable the organizations to deploy human resources effectively while accomplishing the Center's downsizing goals.
- Develop a Strategic Training Framework that will reengineer the assessment process for identifying and prioritizing the Center's developmental requirements.
- Identify and provide essential tools, training, and development necessary to address the present skills imbalance of the staff.
- Design and implement interventions to meet the organizational reengineering requirements of the Center.
- Implement telecommuting program for the Center.
- Support the Agency initiative to replace the HR legacy automated systems with a fully integrated commercial-off-the-shelf (COTS) application.
- Provide quality of work life services to assure that employees can perform their duties in the best of health, well-being, and productivity.

Information Technology-Policy and Oversight

Goal

- The LaRC Office of the Chief Information Officer (CIO) ensures that the Center's acquisition, management, and deployment of information technology (IT) resources is well planned and demonstrates an efficient return on investment that is consistent with the Clinger-Cohen Act of 1996.

Objectives

- Provide leadership and strategy for the implementation of Agencywide initiatives such as Year 2000 and Outsourcing the Desktop Initiative for NASA (ODIN), that are pursued for IT cost effectiveness, infusing new technologies, increasing productivity, and managing the Agency's IT investment.
- Prepare the Center for implementation of ODIN, an initiative to outsource desktop computing and communications across the Agency. ODIN is being developed to meet current and future IT needs in the substantially reduced budget environment. The outsourcing contractor will perform routine IT functions, thus allowing NASA to focus on its core competencies and capabilities.
- Provide Year 2000 leadership, coordination, and consultation to all LaRC organizations in validating Year 2000 risk assessments.
- Provide a focus for Centerwide IT planning, architectures, security, and standards consistent with established Enterprise, Agency, and Federal policies, goals, and standards.
- Support the LaRC Chief Financial Officer in assessing and integrating IT readiness issues into Integrated Financial Management Program (IFMP) implementation planning.

LaRC Implementation Strategy

- Establish an ODIN Implementation Team at LaRC to coordinate all activities associated with the successful outsourcing of desktop computers.
- Provide expertise to assist LaRC organizations in developing strategies to address potential Year 2000 issues.
- Work with the Agency CIO community in setting the appropriate IT standards and policies. Communicate those standards and policies to the Center to assist organizations in effectively managing IT resources.
- Establish and implement processes and tools to facilitate the availability of information about LaRC IT assets.
- Oversee LaRC’s implementation of IT Security initiatives, such as a public key infrastructure (PKI), IT security training and awareness, and system risk assessments.

International Standards Organization 9000

Goals

- To align the management system with best commercial practices. All Centers and NASA Headquarters will third-party certify their management systems to International Standards Organization 9001 requirements by September 1999.
- To achieve certification, the organization will establish, document, implement, and maintain a system that will provide confidence to both the management and the customer that the intended

quality of products and services will be, is being, and has been achieved and that will ensure that the products and services supplied conform to customer requirements.

Objectives

- Contribute directly to our goals as embodied in Langley's Strategic and Quality Framework.
- Improve our critical success factors in all three areas: customer value, stakeholder value, and organizational value.
- Directly improve the quality of our products and services.
- Determine the applicability of the standard to our business and provide validation of applicability to third party assessors.
- Design and implement an efficient, effective, and value-added ISO 9001 program that capitalizes on existing reengineering and reinvention efforts.

LaRC Implementation Strategy

- Project Office has been established to lead the Center's implementation of ISO 9001 standards.
- This Office reports to the Associate Director of Langley who serves as the ISO-9001 management representative and sponsor of the project.
- The Project Office will exist for the time period through certification, approximately 2 years.

Procurement

Goal

- As a customer-based organization, become a valuable contributor on the LaRC team by acquiring goods and services, which meet or exceed our customers' expectations.

Objective

- Emphasize early planning that considers all potential acquisition strategies, and ensure that all the goods and services that are acquired through simplified acquisitions, contracts, grants, cooperative agreements, Economy Act purchases, and NASA Research Announcements are compliant with Federal and NASA regulations and consistent with good business practices.

LaRC Implementation Strategy

- Expand the use of simplified acquisitions up to $5M under the NASA Pilot Program.
- Fully implement electronic commerce in all areas of the acquisition cycle, including the ability for users to obtain equipment and services through direct online ordering.
- Fully automate the proposal evaluation process.
- Expand the use of oral proposals on competitive procurement actions.
- Simplify the evaluation process by eliminating unnecessary steps and adopting appropriate commercial practices and processes.
- Expand use of performance-based contracts, emphasizing work statements, specifications, and delivery schedules.
- Expand the use of cooperative agreements to execute programs by gaining the value from a partnership between government and industry.
- Use Agencywide consolidated contracts for equipment and services common to most Centers to realize significant savings through economies of scale and to significantly reduce the time required for obtaining equipment and services.

- Simplify and automate the bankcard reconciliation for the technical and finance community.

- Continue to pursue outsourcing opportunities in accordance with Workforce 2000 goals.

- Facilitate advocacy with our customers, including legal and technical, to promote teamwork for reducing lead-times and improving the quality of the procurements.

Safety and Mission Assurance, Environmental Programs, and Security

Goals

- Safety—Reduce civil servant lost time occupational injuries. Reduce property loss due to fires or inclement weather. Reduce property loss due to improper facility design or operation.

- Mission Assurance—Achievement of mission success criteria for all spaceflight projects. No damage to aircraft or research equipment on flight research projects. Reduce property loss due to research model failure. Maximize customer satisfaction for supported aeronautics research and technology products.

- Environmental Programs—Support with environmental regulations. Reduce hazardous waste generation. Double the amount of materials recycled from 1997 levels. Increase procurement of paper, tires, concrete, insulation materials, and lubrication oil with recycled content.

- Security—No personnel injury case resulting from acts of violence or traffic incidents. Reduce property losses associated with theft or acts of violence. Minimize security incidents that could lead to loss of sensitive or classified information.

Objectives

- Assure the safety, reliability, quality, and environmental compatibility of the Center's space and aeronautics research and technology products, regardless of whether the products are developed by the Center, contractors, or educational institutions.

- Assure the security, reliability, maintainability, safety, and environmental compatibility of the Center's facilities and the security and safety of the Center's information, operations and functions. The Center will operate a world class safety and health program by becoming STAR certified in OSHA’s Voluntary Protection Program.

LaRC Implementation Strategy

- Develop, in partnership with Center projects and researchers, safe, reliable and environmentally compatible technologies with a pedigree of development, analysis, and tests for ultimate transfer to industry.

- Ensure that wind tunnel and drop models perform as intended and provide the necessary information to research personnel.

- Ensure, in concert with the Center's acquisition function, that contractors and subcontractors deliver products and services which comply with LaRC requirements.

- Provide safety, security, and environmental support to facilitate the Center’s missions.

Technology Transfer

Goal

- Develop and implement innovative technology transfer practices characterized as exemplary that bring significant return on investments to our stakeholders, our customers, and NASA and LaRC missions.

Objectives

- Create optimized partnerships for LaRC's investment in the commercialization program with emphasis on licensing our intellectual property to create wealth, quality jobs, and quality of life opportunities benefiting U.S. taxpayers while advancing our aerospace mission potential.
- Optimize return to Stakeholders through increased visibility of technology transfer successes.

LaRC Implementation Strategy

- Dramatically increase the value of partnerships in commercialization through strategic licenses and partnerships with companies, consortia, and other government agencies.
- Explore traditional and nontraditional activities for technology transfer with small and large businesses recognizing the limits on LaRC's resources and the opportunities of expanded programs through external partnerships.
- Use LaRC Small Business Innovative Research Program (SBIR) to create funded opportunities for industry that will positively impact the Center's effectiveness and will increase the percent of SBIR commercial successes.
- Ensure that return on investment metrics such as royalties to the Center, augmented workforce from partnerships, and accelerated maturation of technology will increase.
- Measure all activities as to their impact on LaRC's Strategic and Quality Framework (SQF) metrics for customers, organization, and stakeholders.
- Expand the use of Memorandum of Agreement (MOA) and Patent License Congressional Announcements, NASA TechTracS Success stories on the World Wide Web, and NASA Tech Briefs to highlight technology transfer successes.

Abbreviations and Acronyms

ARC
Ames Research Center

ASHOE/MAESA
Airborne Southern Hemisphere Ozone Experiment/Measurements for Assessing the Effects of Stratospheric Aircraft

ASPO
Airframe Systems Program Office

AST
Advanced Subsonic Technology

ASTT
Aeronautics and Space Transportation Technology

ATTO
Aerospace Transportation Technology Office

BLM
Bureau of Land Management

CERES
Clouds and the Earth's Radiant Energy System

DAAC
Distributed Active Archive Center

DARPA
Defense Advanced Research Projects Agency

DFRC
Dryden Flight Research Center

DIAL
Differential Absorption Lidar

DoD
Department of Defense

DoE
Department of Energy

DoI
Department of Interior

EOS
Earth Observing System

ES
Earth Science

FAA
Federal Aviation Administration

FIRE
First ISCCP (International Satellite Cloud Climatology Project) Regional Experiment

FTS
Fourier Transform Spectrometry

GAS
Geostationary Atmospheric Sounder

GSFC
Goddard Space Flight Center

GTE
Global Tropospheric Experiment

HALOE
Halogen Occultation Experiment

HEDS
Human Exploration and Development of Space

HPCC
High Performance Computing and Communications

HR
Human Resources

HSCT
High-Speed Civil Transport

HSR
High Speed Research

IMPACT
Interactive Modeling Project for Atmospheric Chemistry and Transport

ISAMS
Improved Stratospheric and Mesospheric Sounder

ISS
International Space Station

LaRC
Langley Research Center

LASE
Lidar Atmospheric Sensing Experiment

LeRC
Lewis Research Center

LITE
Lidar In-space Technology Experiment

LTP
Learning Technologies Project

MSFC
Marshall Space Flight Center

NASA
National Aeronautics and Space Administration

NAST
NPOESS Airborne Sounder Testbed

NDE
Non-Destructive Evaluation

NDSC
Network for the Detection of Stratospheric Change

NOx
Nitrogen oxide

NPOESS
National Polar Orbiting Environmental Satellite System

PEM
Pacific Exploratory Mission

POLARIS
Photochemistry of Ozone Loss in the Arctic Region in Summer

RLV
Reusable Launch Vehicle

RTG
Research Technology Group

SAGE
Stratospheric Aerosol and Gas Experiment

S'COOL
Students' Cloud Observations On-Line

SQF
Strategic and Quality Framework

SRB
Surface Radiation Budget

SS
Space Science

STI
Scientific and Technical Information

STRAT
Stratospheric Tracers of Atmospheric Transport

TMCO
Technical, Management, Cost, and Other Factors

TOMS
Total Ozone Mapping Spectrometer

TRMM
Tropical Rainfall Measuring Mission

TRP
Technology Reinvestment Project

UAV
Uncrewed Aerodynamic Vehicle

USFS
U. S. Forest Service

UNEP/WMO
United Nations Environment Programme/ World Meterological Organization

USMP
United States Microgravity Payload

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The Langley Research Center World Wide Web page is available at the following address:
http://www.larc.nasa.gov/

Appendix A

Programs, Projects, and Activities of Langley Research Center

Aeronautics and Space Transportation Technology Enterprise (ASTT)

- Research and Technology Base
  - Information Systems
  - Airframe Systems (Lead Center)
  - Propulsion Systems
  - Flight Research
  - Aviation Operations Systems (AOS)
  - Rotorcraft
- High Performance Computing and Communications (HPCC)
- High Speed Research HSR (Lead Center)
- Advanced Subsonic Technology (AST) (Lead Center)
- Aviation Safety (Lead Center)
- Space Transportation
  - Reusable Launch Vehicles (RLV)
  - Advanced Space Transportation Program
- Commercial Technology
- Small Business Innovative Research (SBIR)
- Small Business Technology Transfer (STTR)

Earth Science Enterprise (ES)

- Research and Analysis
- Sensors and Detectors Technology Development
- Cloud's and the Earth's Radiant Energy System (CERES) Instrument
- Cloud's and the Earth's Radiant Energy System (CERES) Algorithm Development
- Stratospheric Aerosol and Gas Experiment (SAGE) III Instrument
- Stratospheric Aerosol and Gas Experiment (SAGE) III Algorithm Development
- Stratospheric Aerosol and Gas Experiment (SAGE) III Mission Operations
- Earth Observing System Distributed Active Archive Center (EOSDIS DAAC)
- Space Radiation Budget (SRB) Data Analysis
- Measurement of Air Pollution from Satellite (MAPS)
- Lidar Atmospheric Sensing Experiment (LASE)
- Upper Atmospheric Research Satellite (UARS)
- Halogen Occultation Experiment (HALOE)
- Improved Stratospheric and Mesospheric Sounder (ISAMS)
- Earth Radiation Budget Experiment (ERBE)
- Earth Science
- Stratospheric Aerosol and Gas Experiment (SAGE) II Mission Operations and Data Analysis

Space Science Enterprise (SS)

- Technical, management, cost, and other factors evaluations of Explorer and Discovery proposals as received in response to AO’s
- Independent Assessments
  - Gravity Probe-B
  - Advanced X-Ray Astrophysics Facility
- Explorer Advanced Studies

- Discovery Advanced Planning
- Research and Analysis
- Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX)
- Sounding of the Atmosphere Using Broadband Emission Radiometry (SABER) development for Thermosphere, Ionosphere, Mesosphere Energy and Dynamics (TIMED) Program
- Crosscutting Technology Development
- Planetary Entry
- New Millennium Advanced Concepts
- Mars Surveyor Technology Development and Mission Studies
- Astrophysics Research Associates

Human Exploration and Development of Space Enterprise (HEDS)

- Space Radiation Effects and Protection
- Microgravity Research and Analysis
- Microgravity Flight Projects
- Space Projects Development
- Stratospheric Aerosol and Gas Experiment (SAGE) III Instrument
- Flight Hardware
- Test, Manufacturing, and Assembly
- Flight Technology Demo
- Advanced Projects
- Safety and Performance Upgrade

Appendix B

Contributions of Langley Research Center to the Strategic Enterprises

LaRC Assignments and Activities	ASTT	ES	SS	HEDS
Primary Mission Assignments				
● Airframe Systems	●			
● Atmospheric Science		●		
Center of Excellence Assignment				
● Structures and Materials	●	●	●	●
Lead Program Assignments				
● Advanced Subsonic Technology	●			
● High Speed Research	●			
● Airframe Systems Research and Technology	●			
● Aviation Safety Research	●			
Agency Functional Assignments				
● Independent Program Assessment	●	●	●	●
● RLV Systems Analysis Support	●			●
● Space Science Enterprise Implementation Support			●	
● Wind Tunnel Facility Group	●			
Core Competencies				
● Mission and Systems Analysis, Integrations, and Assessment	●	●	●	●
● Aerodynamics, Aerothermodynamics, and Hypersonic Air-Breathing Propulsion	●		●	●
● Airborne Systems and Crew Station Design and Integration	●			
● Structures and Materials	●	●	●	●
● Atmospheric Sciences and Remote Sensing	●	●	●	●
● Systems Engineering	●	●	●	●
Agency Support Activities				
● Non-Destructive Evaluation	●	●	●	●
● Scientific and Technology Information	●	●	●	●
● Program/Project Management	●	●	●	●

LaRC Assignments and Activities	**ASTT**	**ES**	**SS**	**HEDS**
LaRC Functional and Staff Areas				
• Chief Counsel	●	●	●	●
• Education Programs	●	●	●	●
• Equal Opportunity	●	●	●	●
• External Affairs	●	●	●	●
• Financial Management	●	●	●	●
• Human Resources	●	●	●	●
• Information Systems and Technology	●	●	●	●
• ISO 9000 Implementation	●	●	●	●
• Procurement	●	●	●	●
• Safety and Mission Assurance, Environmental Programs, Security	●	●	●	●
• Technology Transfer	●	●	●	●

The integration team for the 1999 NASA Langley Research Center Implementation Plan included Belinda Adams (sponsor), Don Avery, Pete Covell, David Miller (consultant), Anne Rockey, and Irwin Schauer (leader).